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THESIS

THE EFFECT OF ADVANCED EDUCATION ON THE RETENTION AND THE PROMOTION OF SURFACE WARFARE OFFICERS IN THE U.S. NAVY

by

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March 2012

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THE EFFECT OF ADVANCED EDUCATION ON THE RETENTION AND THE PROMOTION OF SURFACE WARFARE OFFICERS IN THE U.S. NAVY

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LIST OF ACRONYMS AND ABBREVIATIONS

AFRS	Automated Fitness Report System
AOCS	Aviation Officer Candidate School
AVGPI	Average Performance Index
CNA	Center for Naval Analyses
DMDC	Defense Manpower Data Center
GCT	General Classification Test
HMF	Headquarters Master File
IV	Instrumental Variable
LPM	Linear Probability Model
NPS	Naval Postgraduate School
O-4	Major
OLS	Ordinary Least Squares
OMPF	Official Military Personnel File
OMRF	Officer Master Record Files
NEMS	Navy Econometric Modeling System
NROTC	Naval Reserve Officers Training Corps
OCS	Officer Candidate School
OTS	Officer Training School
PLC	Platoon Leaders Class
ROTC	Reserve Officers Training Corps
SWO	Surface Warfare Officers
TBS	The Basic School
U.S.	United States

USMC	United States Marine Corps
USNA	United States Naval Academy

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I. INTRODUCTION

Rapid changes in the international security environment have forced the U.S. military to seek more highly educated personnel who can adapt to rapidly changing circumstances. Kahraman (2007) states that "…the combat area is becoming more complicated in the 21st century, thus requiring more educated and qualified personnel (p. 1). As a result, advanced education plays a critical role in shaping the combat field." Moreover, governments try to retain educated and trained personnel in order to minimize turnover of skilled manpower.

The U.S. military accesses new officers mostly with Bachelor's degrees and then tries to provide advanced education to officers during their careers. Providing advanced education creates highly educated employees who can find multiple analytical solutions to problems, especially in a wartime period. When the military funds graduate education for officers they require an additional service obligation to receive a payback on the investment. Advanced education programs therefore represent an investment in the human capital of the force.

Beside the advantages, there are also some disadvantages of having personnel with advanced degrees in the military. Whenever the obligatory service period ends, personnel with advanced degrees may choose to leave the armed forces for higher-paying civilian jobs. Thus, the military should track officer retention rates in order to make strategic decisions for human capital investment and future manpower requirements. Promotion patterns of officers are also critical in terms of assessing the payoff to the military from its human capital investments. Therefore, analyzing retention and promotion patterns of officers provides important information for decision makers. Moreover, since "…the military's personnel system mimics private firms in many ways" (Bowman and Mehay, 1999, p. 454) (such as training, education, and promotion patterns), not only the military, but also civilian companies and private firms can take advantage of results from this study.

This thesis focuses on the effect of advanced education on the retention and promotion of Navy SWOs in the U.S. Navy. Multivariate models are specified for retention and promotion outcomes. However, analyzing promotion for a sample of stayers from entry cohorts may cause biased estimation because there is no opportunity to observe those officers who separated prior to the promotion point. There may be unobservable factors that predict why individuals stay or leave the Navy and that are also correlated with promotion. All these possibilities should be taken care of to avoid sample selection bias. Thus, Heckman probit model with sample selection method is used to adjust for sample selection bias. The main goal of the study is to find the effects of advanced education on retention and promotion, and several models built to answer these further questions:

1) What is the effect of Master's degree on the retention and promotion of SWOs?

2) What factors, other than education level, affect the retention decisions of SWOs?

3) What factors, other than education level, affect the promotion of SWOs to O-4?

4) What demographic characteristics predict who chooses to pursue an advanced degree or are selected to study for an advanced degree by the Navy?

In order to answer these questions, this thesis uses a data set obtained from the online Navy Econometric Modeling System (NEMS), which includes 73,347 officer-year observations on 14,422 Navy SWOs. Five cohorts are created based on the commissioning dates of the officers from 1996 to 2000. The sample for these five cohorts includes 3,668 officers. Two sub-samples are created for both retention and promotion analyses to see the effect of "unknown education", since the rate of unknown education is high especially for the last two cohorts. The first sample includes officers with unknown education, while the second sample excludes officers with unknown education. Then two more multivariate models are specified to answer some of the questions above by using a sample that consists of the stayers only. However, analyzing only the stayers may cause selection bias. Thus, this study uses a bivariate probit model to correct for selection bias.

Conclusions reached in the thesis will provide information to Navy decision makers about officer retention and promotion patterns. The results may assist the Navy in meeting its manpower requirements at the lowest cost.

Chapter II will discuss some of the previous studies conducted on the effects of graduate education on retention and promotion outcomes of the officers. Chapter III will explain the data used in this study. The methodology and the results of this study will be explained in Chapter IV. Lastly, Chapter V will present the conclusion of the study and the recommendations for future researches.

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II. LITERATURE REVIEW

A. PREVIOUS STUDIES ON GRADUATE EDUCATION OF OFFICERS

1. Wielsma (1996)

Wielsma (1996) analyzed the effects of various factors, including graduate education, on retention to the O-4 promotion board, selection for promotion to O-4, and performance ratings of United States Marine Corps (USMC) officers. Wielsma (1996) emphasized the importance of the study by indicating the efforts of the USMC to achieve a "more effective fighting force" in the face of budget limitations (Wielsma, 1996, p. 1). He also analyzed graduate education while the USMC was undergoing force structure reductions and added that "any research to find out individual factors that affect individual's performance, retention, and promotion probabilities positively would help to increase the quality of the force" (Wielsma, 1996, p. 1). Wielsma (1996) specially focused on whether the performance of officers with graduate educations was higher than officers without postgraduate degrees. He also determined whether those with advanced degrees stayed in service at higher rates than those without graduate education.

Wielsma (1996) created a data set which merged information from the Defense Manpower Data Center (DMDC) with the USMC's Automated Fitness Report System (AFRS), the USMC Headquarters Master File (HMF) and the USMC's Official Military Personnel File (OMPF). Each officer in the data set entered the USMC in 1980 and was tracked longitudinally until 1994. He created two data samples. The first one included all commissioned officers who joined in 1980. Additionally, he dropped the officers with pay grades above second lieutenant at entry, those with missing information in key variables, and those with no college degrees. After these reductions, the first data sample included 1,087 observations (Wielsma, 1996). A second data sample was created to analyze promotion outcomes for officers who stayed in the Marine Corps long enough to appear before the O-4 promotion board (roughly 10 years of service). Wielsma (1996)

pointed out that the sample was an "approximation because actual promotion board data were not obtained for the study" (p. 29).

Wielsma (1996) used non-parametric, ordinary least squares (OLS), and non-linear maximum likelihood (probit) techniques in his study. For the study, he used two binary dependent variables; STAYPROM represented officers who stayed until the O-4 promotion point and PROMOTE represented those who were promoted to O-4. Wielsma (1996) also specified a graduate education selection model to control for selection bias. He included the inverse Mills' ratio in the promotion model to control for potential biases from sample selection.

Wielsma (1996) used four different models to analyze the factors that affect the promotion patterns of officers. In his first model he used a simple probit regression model and found that officers with postgraduate degrees were more likely to be promoted. In the second model he added General Classification Test scores (GCT) as an independent variable to control for any potential bias due to aptitude and found that officers with postgraduate degrees still were much more likely to be promoted. In the third model he exchanged the GCT variable with the average performance index (AVGPI), which uses fitness report information to measure an individual's on-the-job performance, and found that the probability of being promoted for the officers with postgraduate degrees was still much higher than other officers. In the fourth model he included both GCT and AVGPI variables in the model and found little change in the effect of graduate education.

Wielsma (1996) used two different models to analyze retention patterns. In the first model he used a simple probit regression model and found that officers with postgraduate degrees were far more likely to stay in the service. In the second model he added an AVGPI variable to correct for selection bias and found that the probability of staying in the service for officers with postgraduate degrees was still very high.

Wielsma (1996) also used three OLS regression models to analyze the promotion patterns. In the first model he used a simple OLS method and found that postgraduate degrees increased the probability of being promoted by 9% (with AVGPI) and by 15% (without AVGPI). In the second model he added "the selection bias correction term from

the graduate education selection model (MILLS1)" to the model and found that postgraduate degrees decreased the probability of being promoted by 45% (with AVGPI) and increased the probability of being promoted by 284% (without AVGPI). Lastly, in the third model, he added "the selection bias correction term from the retention selection model (MILLS2)" to the model and found that postgraduate degrees decreased the probability of being promoted by 8% (with AVGPI) and decreased the probability of being promoted by 7% (without AVGPI) (pp. 50–51–55).

Having reached those results, he stated that "graduate education appeared to have a positive effect on promotion; however, failure to correct for retention and selection issues biased the estimated effects of graduate education upward" (Wielsma, 1996, p. v).

2. Bowman and Mehay (1999)

Bowman and Mehay (1999) examined the relationship between graduate education and on-the-job performance using data from Navy officers. They emphasized the importance of their study by indicating that prior studies had reached inconsistent results on the relationship between graduate degrees and job performance in civilian firms (Bowman & Mehay, 1999). Thus, their goal was to shed light on the job performance effects of graduate education using data on military officers.

Their data set contained detailed information about line and staff naval officers' promotion outcomes, performance ratings, and numerous background characteristics (Bowman & Mehay, 1999, p. 453). Their data set was created using information from the Navy's Promotion History File between the years 1985 and 1990. Bowman and Mehay (1999) also included information on officer fitness reports. The final data set included 6,583 officers who were reviewed for promotion to grade 4.

Since their study was about the relationship between graduate education and on-the-job performance, Bowman and Mehay (1999) used promotion as the indicator of performance. At first, they estimated a simple probit promotion model and found that graduate education was positive and significant. Line officers with Master's degrees had a promotion probability that is 9.8 percentage points higher, while it was 14.5 percentage points for staff officers (Bowman & Mehay, 1999). In order to control for any potential

selection bias, Bowman and Mehay (1999) added "controls" to the model, which represented the "ability of the officers selected for the fully-funded graduate education and the administrative criteria to choose them" (p. 457). In this model, "the coefficient of graduate education (Master's) degree decreased by about 20%" (Bowman & Mehay, 1999, p. 457). Bowman and Mehay (1999) then estimated a bivariate probit model to better control for selection bias. This involved the use of an instrumental variable (IV) in the graduate education selection model, since an IV estimate helps to reach unbiased results when explanatory variables are correlated with the error term in the promotion model. They found that the positive effect of Master's degree in the bivariate probit promotion models for line and staff officers were 25–50% lower than in the single-stage probit model (Bowman & Mehay, 1999).

Nonetheless, Bowman and Mehay (1999) summarized that "officers with any kind of graduate degrees" were 10–15 points more likely to be promoted, whereas the officers with graduate degrees from "Navy's fully-funded educational programs" were 15–17 points more likely to be promoted (p. 460). However, they also found that selection bias accounted for as much as 40–50% of the promotion effect of graduate education (Bowman & Mehay, 1999).

3. Conzen (1999)

Conzen (1999) also investigated the effects of fully funded graduate education on the retention of naval officers. Conzen (1999) justified his study by emphasizing that low civilian unemployment rates tend to reduce retention rates of Navy officers. He added that "previous studies had not thoroughly examined the effect of graduate education on the retention of the officers past the mandatory service incurred for accepting a government funded education" (pp. xiii–1).

Conzen (1999) used data from the Officer Master Record Files (OMRF) provided by DMDC. The data sets captured all naval officers who were eligible for voluntary separation each year from 1992 to 1997 (Conzen, 1999, p. v). He also added that officers who left the service involuntarily, retired, or had obligatory service due to postgraduate

education were dropped from the data sets. After cleaning the data set, 33,000 to 41,000 observations were left in each year.

Conzen (1999) used a logit model to identify the factors that affect retention of naval officers, on a year-to-year basis (p. xiii). He created the binary dependent variable QUIT, which represented the leavers.

Conzen (1999) used different models for each annual data set (from 1992 to 1997), and created the base reference group as Surface Warfare Lieutenant with no college degree, an unknown number of dependents, and unknown race. For year 1992, Conzen (1999) stated that Naval Postgraduate School (NPS) Master's degrees, other funded Master's degrees, and non-funded Master's degrees increased the probability of staying by 46.5%, 47.85%, and 48.82%, respectively, and that funded PhDs and non-funded PhDs increased the probability of staying by 38.46% and 48.37%, respectively. The marginal effects of advanced educational degrees on retention for years 1993 through 1997 were as follows:

Years	NPS Master's Degree	Other Funded Master's Degree	Non-Funded Master's Degree	Funded PhD	Non-funded PhD
1993	-47.5%	-44.00%	-42.3%	-47.00%	-32.95%
1994	No information was given about the marginal effects				
1995	45.30%	45.76%	-47.00%	-49.00%	-43.29%
1996	48.60%	46.50%	-47.9%	42.00%	-37.05%
1997	-49.5%	-47.25%	-48.13%	35.66%	-42.31%

Figure 1. Logit Model Estimations for Advanced Degrees in Retention Analysis (From: [1])

As a result of his study, Conzen (1999) stated that "a funded graduate education didn't have a significant effect on retention past mandatory service lengths, but the proportion of officers with funded Master's degrees were less likely to leave the Navy than the officers who earned a Master's degree on their own or had only a Bachelor's degree" (p. 26).

[1] Modified table from (Conzen, 1999, pp. 22-32-33-34-35)

4. Branigan (2001)

Branigan (2001) analyzed the factors that affected the retention and promotion of USMC officers. He "focused on the economic returns to graduate education, especially for the Naval Postgraduate School (NPS) education" (Branigan, 2001, p. v).

Branigan (2001) emphasized the importance of his study by pointing out the changeable and uncertain future of 21st century Marine Corp operations, and argued that "education would be the only tool to prepare Marines to that uncertainty while improving the ability to adapt more quickly to the changing environment" (p. 1). Therefore, he examined differences in retention and promotion rates between officers with and without graduate degrees. Moreover, he touched on the economic theory of human capital and emphasized that "traditionally, productivity was measured through level of pay; however, since the military pay system was not structured to reflect on-the-job productivity differences, alternative indicators such as retention, performance reports, and promotion should be used to estimate the payoff from graduate education and to measure return on investment" (Branigan, 2001, p. 2).

Branigan (2001) obtained data from many sources. Information on lieutenant colonel promotion boards from FY1998 through FY2001 were collected from the Manpower Plans Division at Headquarters Marine Corps. Information on accession cohorts (1980-1984) was obtained from the "…'Longitudinal TBS File' provided by the Center for Naval Analyses (CNA) and DMDC. Data regarding graduate education were collected from the Registrar at NPS on all Marines who graduated between 1983 and 2000" (pp. 27–28). The cohort sample included 6,507 observations, and the promotion sample included 1,627 observations that stayed to the O-5 promotion point (Branigan, 2001, pp. 45–50).

Branigan (2001) chose "nonparametric analysis and simple probit techniques to estimate retention and promotion models" (p. v). For the retention analysis, he used the SURVIVE binary dependent variable that captured those who stayed until the O-5 promotion point and the SELECT binary dependent variable for those who were promoted to O-5 (Branigan, 2001, pp. 57–60). He applied "several statistical techniques

to avoid self-selection and sample selection biases". However, he emphasized that "results from the techniques were not conclusive since the results proved sensitive to slight changes in model specification" (Branigan, 2001, p. v).

In the retention analysis, Branigan (2001) found that "an officer with a graduate degree, no matter which source the degree was from, was 12 percentage points more likely to survive than an officer without a graduate degree" (p. 59). Officers with NPS graduate degrees were 10.5 percentage points more likely to survive than officers without a graduate degree, and officers with non-NPS graduate degrees officers were 12.4 percentage points more likely to survive than officers with no graduate degrees (Branigan, 2001, p. 59).

In the promotion analysis, Branigan (2001) found that an officer with a graduate degree was 21.5 percentage points more likely to be promoted to O-5 than an officer with no graduate degree (p. 60). However, including the performance measures (performance evaluation index, number of personal awards and professional military education level) in the model reduced the probability by six points to 15.04 percentage points (Branigan, 2001, p. 61).

Branigan (2001) also estimated a bivariate probit with a sample selection technique to estimate the joint probability of the both retention and promotion to O-5. He found that "an officer with a graduate degree from any source was 13.5 percentage points more likely to survive and be promoted to O-5 than an officer with no graduate degree" (pp. 65–67). In addition, an officer with a graduate degree from NPS was 8 percentage points more likely to survive to the O-5 promotion point and be promoted than an officer with no graduate degree. An officer with a graduate degree from non-NPS sources was 13.5 percentage points more likely to survive and be promoted (Branigan, 2001, p. 68). Branigan (2001) also used the Heckman Procedure to deal with self-selection bias and reached consistent results with the previous models (pp. 68–70–71). Although Branigan (2001) used several techniques to avoid self-selection bias, he indicated that bivariate probit models for sample selection were not adequately specified and the results were implausibly large.

Nonetheless, Branigan (2001) concluded that "graduate degrees, both from NPS and other sources, have positive effects on the retention and promotion of Marine Corps officers" (p. v).

5. Kahraman (2007)

Kahraman (2007) examined the effects of advanced education on the retention and the promotion of Army officers. He stressed the importance of graduate education by emphasizing "the complex atmosphere of the 21st century's combat area, thus the necessity for more educated and qualified personnel, since education increases the utilization of those complicated systems" (Kahraman, 2007, p. 1).

Kahraman (2007) used a data set from the Active Duty Military Master File provided by the DMDC. The data provided information on Army officers commissioned between 1981 and 2001. Although there were more than 100,000 observations in the data set, only 45,228 were used for the retention analysis, and 12,092 were used for the promotion analysis due to missing information on key variables (Kahraman, 2007, p. 59).

The author compared "promotion rates among four education categories: college degree only, Master's degree, Doctorate degree, and professional degree" (Kahraman, 2007, p. 3). Moreover, Kahraman (2007) compared survival rates of officers by educational level.

Kahraman (2007) "tracked the officers in each cohort until they separate from active duty, used survival analysis as an empirical approach, and estimated the survival models both for promotion patterns and the retention of Army officers" (p. 5). He explained the reason for using survival analysis was to analyze the occurrence and timing of promotion and retention (Kahraman, 2007, pp. 39–40). The author "combined two main variables to create the dependent variable for survival analysis: duration (YEARSSERVED—how long it takes to leave the Army—for the retention model, and TIMEYRS—how long it takes to be promoted to O-4—for the promotion model), the censoring variable (STAY—whether an officer stayed in the Army until 2004—for the retention model, and PROMO4—whether and officer was promoted to O-4—for the promotion model)" (Kahraman, 2007, p. 47).

In the retention analysis, Kahraman (2007) observed that "at the end of their initial service obligation years, officers' separation rates increased depending on their commissioning sources" (p. 145). All else equal, "the expected survival time for an officer with a Master's degree was 29.13% higher than an officer with a Baccalaureate degree, an officer with a Doctorate degree had 23.94% higher expected survival time than an officer with a Baccalaureate degree, and the expected survival time of an officer with a professional degree was 8.21% higher than the one with a Baccalaureate degree only" (Kahraman, 2007, pp. 145–146). Kahraman (2007) concluded that officers with advanced education were less likely to leave than officers with only college degrees (p. 147). In the promotion analysis, the author found that officers with Master's degrees had 0.21% less expected time to promotion to Major than the officers with a Baccalaureate degree. He found that "although the professional degree had no significant effect on the hazard of promotion to O-4, a Master's degree or a Doctorate degree owner had 115.3% higher probability on the hazard of being promoted than an officer with a college degree" (Kahraman, 2007, p. 150).

As a result of his study, Kahraman (2007) said that "having an advanced educational degree increased the probability of being promoted to Major (O-4), decreased the time to promote to O-4, and increased the probability of staying in the service for Army officers" (p. 151). Moreover, Kahraman (2007) hypothesized that an advanced educational degree could be a "signal to an officer's ability and productivity" since it positively correlated with the promotion patterns of the Army officers and negatively correlated with the time required for the promotion to O-4 (p. 152).

B. SUMMARY OF PREVIOUS STUDIES

The results from the previous studies are summarized in Figure 1.

Wielsma (1996) used non-parametric analysis, OLS and simple probit model. Bowman and Mehay (1999) used simple probit and bivariate probit models. Conzen (1999) used logit model in his study. Non-parametric analysis, simple probit model, bivariate probit model and Heckman two stage probit model used in Branigan's (2001) study. Finally, Kahraman (2007) used survival analysis in his study.

In the retention analysis, Conzen (1999), Wielsma (1996), Branigan (2001) and Kahraman (2007) found that Master's degree holders are more likely to stay in service. Conzen found that, Master's degree holders are less likely to stay in service for year 1993 and 1997.

In the promotion analysis Wielsma (1996), Bowman and Mehay (1999), Branigan (2001), and Kahraman (2007) found that Master's degree holders are more likely to be promoted.

The previous studies indicate that graduate education has a positive effect on both retention and promotion.

STUDY BY	RESEARCH GROUP	RESEARCH AREA	METHODOLOGY	DATA FROM	SAMPLE SIZE	FINDINGS	
						Retention	Promotion
Wielsma (1996)	US Marine Corps (USMC)	Analyzed the effects of various factors, including graduate education, on retention to the O-4 promotion board, selection for promotion to O-4, and performance ratings.	Non-parametric analysis, OLS, Simple Probit Model	The Defense Manpower Data Center (DMDC) with the USMC's Automated Fitness Report System (AFRS), the USMC Headquarters Master File (HMF) and the USMC's Official Military Personnel File (OMPF)	1,087	Simple Probit Model: Advanced degree holders are more likely to stay by **106.56** percentage points. Controlling for Bias with one IV: Advanced degree holders are more likely to stay by **86.32** percentage points.	Simple Probit Model: Advanced degree holders are more likely to be promoted by **47.61** percentage points. Controlling for Bias with one IV: Advanced degree holders are more likely to be promoted by **47.76** percentage points. Controlling for Bias (exchanged IV): Advanced degree holders are more likely to be promoted by **39.09** percentage points. Controlling for Bias with two IVs: Advanced degree holders are more likely to be promoted by **38.73** percentage points.
Bowman and Mehay (1999)	Navy Officers	Examined the relationship between graduate education and on-the-job performance.	Simple Probit Model, Bivariate Probit Model	The Navy's Promotion History File between the years 1985 and 1990, and officer fitness reports.	6,583	NA	Simple Probit Model: Line and Staff officers with Master's degrees are more likely to be promoted by **9.8** and **14.5** percentage points, respectively. Controlling for bias with ability/performance: Line and Staff officers with Master's degrees are more likely to be promoted by **6.5** and **8.9** percentage points, respectively. Bivariate Probit Model: Line and Staff officers with Master's degrees are more likely to be promoted by **5.6** and **5.1** percentage points, respectively.
Conzen (1999)	Navy Officers	Investigated the effects of fully funded graduate education on the retention.	Logit Model	Officer Master Record Files (OMRF) provided by DMDC	33,000 to 40,000	Year 1992: Master's degree holders are more likely to stay by **46.5%-48.8%**. Year 1993: Master's degree holders are less likely to stay by **42.3%-47.5%**. Year 1995: Master's degree holders are more likely to stay by **45%,** and **47%** less likely to stay for non-funded MAs. Year 1996: Master's degree holders are more likely to stay by **46%-48%**, and **47.9%** less likely to stay for non-funded MAs. Year 1997: Master's degree holders are less likely to stay by **47%-49%**.	NA
Branigan (2001)	US Marine Corps (USMC)	Analyzed the factors that affected the retention and the promotion.	Non-parametric analysis, Simple Probit Model, Bivariate Probit Model, Heckman Two-Stage Probit Model with Sample Selection	Manpower Plans Division at Headquarters Marine Corps, Center for Naval Analyses (CNA) and DMDC, Registrar at NPS	6,507 and 1,627 for promotion analysis	Simple Probit Model: Master's degree holders are more likely to stay by **12** percentage points.	Simple Probit Model: Master's degree holders are more likely to be promoted by **21.5** percentage points. Controlling for bias with performance: Master's degree holders are more likely to be promoted by **15.04** percentage points. Bivariate Probit Model: Master's degree holders are more likely to survive and be promoted by **13.5** percentage points. Heckman Procedure: Master's degree holders are more likely to be promoted by **22.95** percentage points.
Kahraman (2007)	Army Officers	Examined the effects of advanced education on the retention and the promotion.	Survival Analysis	Active Duty Military Master File provided by the DMDC	45,228 for retention analysis and 12,092 for promotion analysis	Master's degree holders are more likely to stay by **29.13%**. Doctorate degree holders are more likely to stay by **23.94%**. Professional degree holders are more likely to stay by **8.21%**.	Master's and Doctorate degree holders are more likely to be promoted by **115.3%**. Professional degree does not have significant effect on promotion.
Abunaz and Torun (2012)	Navy Surface Warfare Officers	Examined the effects of advanced education on the retention and the promotion.	Simple Probit Model, Heckman Two-Stage Probit Model with Sample Selection, Bivariate Probit Model	The online Navy Econometric Modeling System (NEMS)	3,668 for retention analysis and 1,850 for promotion analysis	Simple Probit Model: Master's degree holders are more likely to stay by **48.5** percentage points. Doctorate degree holders are less likely to stay by **21.9** percentage points. First Professional degree holders are more likely to stay by **20.7** percentage points.	Simple Probit Model: Master's degree holders are more likely to be promoted by **31.6** percentage points. Doctorate degree holders are less likely to be promoted by **34.3** percentage points. First Professional degree holders are less likely to be promoted by **35.6** percentage points. Heckman Procedure: Master's degree holders are more likely to be promoted by **36.1** percentage points. Doctorate degree holders are less likely to be promoted by **43** percentage points. First Professional degree holders are less likely to be promoted by **95.2** percentage points. Bivariate Probit Model: Master's degree holders are more likely to survive and be promoted by **210.4** percentage points.

Figure 2. Comparison of Previous Studies.

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III. DATA

Chapter III presents the data set used in this study, and provides descriptive statistics on retention and promotion rates. The variables created for the multivariate models are the same for both the retention and promotion models. The chapter also discusses the limitations of the data set used in this study.

A. DATA DESCRIPTION

The data set used in this study was obtained from the online Navy Econometric Modeling System (NEMS). It was constructed from annual snapshots of SWOs in the Navy between 2000 and 2011 and contains information on 14,422 Navy officers. The full panel of data is not balanced, as some officers left the Navy before 2011. Thus the data set includes 73,347 officer-year observations.

Table 1 provides the definitions of all variables. For some officers, educational attainment is listed as "unknown." As the goal of this study is to analyze the effect of advanced education on the retention and the promotion of O-3-level Navy SWOs, models used in this study are estimated with and without officers with unknown educational attainment in the sample.

The data set includes information on Navy officers from pay grade levels O-1 to O-10. Table 2 shows descriptive statistics for all variables in the data set including "unknown" educational degrees and Table 3 shows descriptive statistics for all variables in the data set that excludes those with "unknown" educational degrees. For example in the 1996 cohort, 85.2% of the sample has a Bachelor's degree. This percentage is 79%, 78.2%, 69%, and 56.1%, respectively, for years 1997, 1998, 1999, and 2000. The Bachelor's degree holders' ratio for the full sample is 72%. It is obvious that there was a significant drop in the rates for Bachelor's degree holders in the years 1999 and 2000. This drop was likely due to the increase the number of unknown degree holders.

As mentioned, two analyses are implemented, one with and one without officers with "unknown" degrees, to explore if estimated results are sensitive to this choice. The percentage of Master's degree recipients, are 7.5%, 10.4%, 9.6%, 8.3%, and 18.7% for years 1996, 1997, 1998, 1999, and 2000, respectively. In the total

sample, the rate of Master's degree holders is 11.3%. The significant increase in the rate for year 2000 is due to the reason mentioned previously. The rate of Doctorate degrees, First Professional degrees, and other degree recipients remained almost constant throughout the years because of their small numbers. Lastly, the rate of officers with "unknown" degrees are 2.2%, 1.9%, 4.9%, 14.2%, and 20.3% in 1996, 1997, 1998, 1999, and 2000, respectively.

VARIABLES	DESCRIPTION
DEPENDENT VARIABLE	
Stayed Officers	=1 if stayed until the end of tenth year in service; 0 otherwise
Promoted Officers	=1 if promoted in tenth year of service; 0 otherwise
INDEPENDENT VARIABLES	
PRIOR SERVICE	
Officers without Prior Service	=1 if had no prior service before commissioning date; 0 otherwise
Officers with Prior Service	=1 if had prior service before commissioning date; 0 otherwise
EDUCATIONAL DEGREES	
Bachelor's Degree	=1 if obtained a Baccalaureate degree, or Associate degree; 0 otherwise
Master's Degree	=1 if obtained a Master's degree; 0 otherwise
Doctorate Degree	=1 if obtained a Doctorate degree; 0 otherwise
First Professional Degree	=1 if obtained First Professional degree ; 0 otherwise
Other Degree	=1 if obtained a high school diploma, or an occupational program certificate, or completed one semester college but no high school diploma; 0 otherwise
Unknown Degree	=1 if the educational degree is not known; 0 otherwise
RACE	
White Officers	=1 if white; 0 otherwise
Black Officers	=1 if black; 0 otherwise
Officers with Other Races	=1 if race is one of Asian type, or American Indian/Alaska Native types, or one of Asian types, or black/African American/white, or Native Hawaiian/other Pacific islands, or unknown; 0 otherwise
GENDER	
Female	=1 if female; 0 otherwise
Male	=1 if male; 0 otherwise
ACCESSION SOURCES	
OCS	=1 if OCS, or AOCS, or OTS, or PLC source; 0 otherwise
ROTC Scholarship Program	=1 if ROTC/NROTC scholarship program; 0 otherwise
U.S. Naval Academy	=1 if U.S. Naval Academy source; 0 otherwise
Other Sources	=1 if other source, or ROTC/NROTC non-scholarship program, or direct appointment authority/commissioned off professional / all other, or unknown source, or other sources, or USAF; 0 otherwise
MARITAL STATUS	
Married Officers	=1 if married; 0 otherwise
Single Officers	=1 if single; 0 otherwise
DEPENDENTS	
No dependents	=1 if no dependent; 0 otherwise
One or more dependent(s)	=1 if one or more dependents; 0 otherwise
COHORTS	
1996 Entrants	=1 if commissioning year is 1996 and file year is 2006; 0 otherwise
1997 Entrants	=1 if commissioning year is 1997 and file year is 2007; 0 otherwise
1998 Entrants	=1 if commissioning year is 1998 and file year is 2008; 0 otherwise
1999 Entrants	=1 if commissioning year is 1999 and file year is 2009; 0 otherwise
2000 Entrants	=1 if commissioning year is 2000 and file year is 2010; 0 otherwise

Table 1. Variable Descriptions.

	PERCENT DISTRIBUTION OF OFFICERS BY VARIABLE/BY COHORT					
	1996	1997	1998	1999	2000	TOTAL N=3668
PAY GRADE						
O-1	0.00%	0.00%	0.14%	0.50%	0.22%	0.19%
O-2	2.54%	10.96%	14.90%	18.44%	19.49%	14.09%
O-3	61.76%	58.45%	56.83%	53.83%	52.12%	56.11%
O-4	35.53%	30.59%	28.14%	27.23%	28.17%	29.58%
O-5	0.17%	0.00%	0.00%	0.00%	0.00%	0.03%
PRIOR SERVICE STATUS						
Yes	43.49%	43.68%	40.55%	34.38%	39.53%	39.99%
No	56.51%	56.32%	59.45%	65.62%	60.47%	60.01%
EDUCATIONAL DEGREES						
Bachelor's Degree	85.28%	79.00%	78.21%	69.01%	56.12%	72.08%
Master's Degree	7.45%	10.35%	9.66%	8.28%	18.71%	11.34%
Doctorate Degree	2.03%	3.04%	2.34%	3.39%	2.45%	2.67%
First Professional Degree	0.17%	0.30%	0.55%	0.50%	0.56%	0.44%
Other Degree	2.88%	5.33%	4.28%	4.64%	1.78%	3.71%
Unknown Degree	2.20%	1.98%	4.97%	14.18%	20.38%	9.76%
RACE						
White	79.02%	74.58%	79.31%	81.18%	78.62%	78.65%
Black	8.29%	12.94%	9.10%	9.79%	11.92%	10.50%
Other	12.69%	12.48%	11.59%	9.03%	9.47%	10.85%
GENDER						
Female	15.91%	12.33%	16.00%	21.20%	23.39%	18.27%
Male	84.09%	87.67%	84.00%	78.80%	76.61%	81.73%
ACCESSION SOURCES						
OCS	20.81%	23.74%	32.55%	29.49%	32.29%	28.35%
Other	9.48%	10.50%	8.14%	6.02%	7.80%	8.23%
ROTC Scholarship	32.66%	29.83%	28.14%	37.64%	34.30%	32.74%
USNA	37.06%	35.92%	31.17%	26.85%	25.61%	30.67%
MARITAL STATUS						
Married	56.35%	53.58%	50.76%	49.06%	51.89%	52.07%
Single	43.65%	46.42%	49.24%	50.94%	48.11%	47.93%
DEPENDENTS						
No Dependents	45.35%	47.03%	45.38%	42.91%	42.65%	44.47%
One or More Dependents	54.65%	52.97%	54.62%	57.09%	57.35%	55.53%

Table 2. Descriptive Statistics for the Full Sample.

	PERCENT DISTRIBUTION OF OFFICERS BY VARIABLE/BY COHORT					
	1996	1997	1998	1999	2000	TOTAL N=3310
PAY GRADE						
O-1	0.00%	0.00%	0.15%	0.44%	0.14%	0.15%
O-2	2.60%	10.56%	14.08%	17.40%	19.16%	13.17%
O-3	61.25%	58.39%	56.46%	51.17%	50.63%	55.32%
O-4	35.99%	31.06%	29.32%	30.99%	30.07%	31.33%
O-5	0.17%	0.00%	0.00%	0.00%	0.00%	0.03%
PRIOR SERVICE STATUS						
Yes	43.25%	43.94%	41.07%	37.72%	39.72%	41.03%
No	56.75%	56.06%	58.93%	62.28%	60.28%	58.97%
EDUCATIONAL DEGREES						
Bachelor's Degree	87.20%	80.59%	82.29%	80.41%	70.49%	79.88%
Master's Degree	7.61%	10.56%	10.16%	9.65%	23.50%	12.57%
Doctorate Degree	2.08%	3.11%	2.47%	3.95%	3.08%	2.96%
First Professional Degree	0.17%	0.31%	0.58%	0.58%	0.70%	0.48%
Other Degree	2.94%	5.43%	4.50%	5.41%	2.24%	4.11%
RACE						
White	79.24%	75.47%	80.41%	80.70%	77.62%	78.70%
Black	7.96%	12.73%	9.00%	9.80%	13.71%	10.73%
Other	12.80%	11.80%	10.60%	9.50%	8.67%	10.57%
GENDER						
Female	16.09%	12.42%	16.40%	20.18%	23.92%	17.98%
Male	83.91%	87.58%	83.60%	79.82%	76.08%	82.02%
ACCESSION SOURCES						
OCS	20.76%	23.29%	31.35%	28.95%	24.76%	26.01%
Other	9.00%	10.09%	7.55%	5.41%	7.83%	7.92%
ROTC Scholarship	33.39%	30.28%	28.45%	38.45%	35.52%	33.26%
USNA	36.85%	36.34%	32.66%	27.19%	31.89%	32.81%
MARITAL STATUS						
Married	56.57%	53.73%	50.94%	50.73%	52.59%	52.78%
Single	43.43%	46.27%	49.06%	49.27%	47.41%	47.22%
DEPENDENTS						
No Dependents	44.98%	46.89%	45.57%	40.64%	41.82%	43.90%
One or More Dependents	55.02%	53.11%	54.43%	59.36%	58.18%	56.10%

Table 3. Descriptive Statistics Excluding Officers with "Unknown Education" from the Full Sample.

B. SUMMARY OF DATA FOR RETENTION AND PROMOTION ANALYSES

For the retention model, cohorts based on the entry years of the officers were created, and their retention from entry to the tenth year of service was tracked. For example, the first cohort is based on officers who entered the Navy in 1996. Their retention behavior was tracked between 1996 and 2006. All cohorts were created with the same logic. The last cohort was created for 2000 entrants, who were tracked until 2010. After creating five cohorts from the officers who were in their tenth year of service, the sample size dropped from 14,422 to 3,668.

Table 4 provides descriptive statistics for the five entry cohorts in the full sample. For example, for the 1996 cohort, the promotion rate for those with MA degrees is 80.95%. Table 5 provides descriptive statistics for the sample that deletes observations with "unknown" educational degrees. As shown in column 1 in Table 4, the first cohort starts with 1996 entrants and includes 591 officers. Of these officers, 249 (42.1%) officers separated before the end of their tenth years in service. Of the 342 (57.8%) officers who stayed until the end of the tenth year, 210 officers were promoted, a promotion rate of 61.4%. Cohort 1997 contains 657 officers, of whom 295 (44.9%) left by the end of the tenth year. Out of the 362 who stayed, 198 were promoted in their tenth year, a promotion rate of 54.7%. In cohort 1998, 362 (49.9%) officers stayed, out of 725 officers. In their tenth year, 201 (55.5%) of the officers who stayed were promoted. The year 1999 cohort consisted of 797 officers, 424 (53.2%) of whom separated. Out of those officers who stayed, 215 officers (57.6%) were promoted in their tenth year. Cohort 2000 included 898 officers; 487 officers (54.2%) separated and 411 officers (45.7%) stayed. In their tenth years of service, 248 (60.3%) officers of those who stayed were promoted to O-4. The total sample size is 3,668 officers; 1818 (49.5%) of them separated in ten years, and 1,850 officers (50.4%) stayed. The promotion rate for the 1,072 officers who stayed is 57.9%.

For all cohorts, 67.2% of all officers with prior service stayed. The promotion rate for officers with prior service was 59.1%. For officers without prior service, the retention rate was 39.2% and their promotion rate was 56.6%.

There were 1,180 (44.6%) officers with Bachelor's degrees who stayed until the end of their tenth years. Out of 1,180 officers, 628 officers were promoted, which is 53.2% of total Bachelor's degree recipients. Of those officers with doctorate

degrees, 45 (45.9%) stayed to the end of their tenth years in service, and out of those who stayed 14 (31.1%) were promoted to O-4. The number of First Professional degree holders at the end of their tenth years was 13 (81.2%) and then promotion rate for was 23%. Officers with associate degrees, high school diplomas, or occupational program certificates were grouped as “other degrees” because the numbers of these degrees were very low. When added to the multivariate models as a separate education category, the sample number of observation caused estimation problem. The promotion rate for the officers with other degrees was 41.5%. 122 (9.7%) officers’ educational degrees were unknown in the data set. The promotion rate for those officers was 39.3%.

For the full sample, the retention rate for whites was 48.5% compared to 60% for blacks. Other races include American Indian/Alaska natives, one of mixed Asian types, black/African American/white, or native Hawaiian/from other Pacific islands. The retention rate for that group was 54.7% and the promotion rate 57.3%.

For the full sample, the retention rate for female officers was 36% compared to 54% for male officers. For married officers, the retention rate was 65% but only 35% for single officers. The promotion rate for female officers was 48% out of all female officers who stayed compared to 59.5% for male officers. The promotion rate of married officers was 68.3% compared to the 37.1% for promotion rate of single officers.

Out of 1,850 officers who stayed, 705 (38.1%) officers were from OCS, AOCS, OTS, or PLC. 208 (11.2%) officers were from other sources, 494 (26.7%) officers were from ROTC/NROTC scholarship programs, and 443 (23.9%) officers were graduates of the United States Naval Academy (USNA).

The retention rate for the officers with no dependents was 36.8% compared to 61.4% for officers with one or more dependents. The promotion rates for those officers were 40.3% and 66.4%, respectively.

		COHORT					
		1996	**1997**	**1998**	**1999**	**2000**	**TOTAL**
Number of Observations →		591	657	725	797	898	**3668**
DEPENDENT VARIABLES							
Stayed Officers		57.87%	55.10%	49.93%	46.80%	45.77%	**50.44%**
Promoted Officers (Out of Stayers)		61.40%	54.70%	55.52%	57.64%	60.34%	**57.95%**
PRIOR SERVICE STATUS							
Officers without Prior Service	STAY	50.00%	43.24%	38.75%	35.56%	33.89%	**39.25%**
	PROM	61.68%	53.75%	49.70%	57.53%	59.78%	**56.60%**
Officers with Prior Service	STAY	68.09%	70.38%	66.33%	68.25%	63.94%	**67.21%**
	PROM	61.14%	55.45%	60.51%	57.75%	60.79%	**59.13%**
EDUCATIONAL DEGREES							
Bachelor's Degree	STAY	53.77%	49.90%	44.27%	44.00%	31.15%	**44.63%**
	PROM	58.30%	50.19%	52.99%	58.26%	42.04%	**53.22%**
Master's Degree	STAY	95.45%	94.12%	94.29%	95.45%	95.83%	**95.19%**
	PROM	80.95%	81.25%	84.85%	88.89%	88.20%	**85.86%**
Doctorate Degree	STAY	75.00%	50.00%	58.82%	40.74%	22.73%	**45.92%**
	PROM	66.67%	50.00%	10.00%	18.18%	0.00%	**31.11%**
First Professional Degree	STAY	100.00%	100.00%	75.00%	75.00%	80.00%	**81.25%**
	PROM	100.00%	0.00%	0.00%	66.67%	0.00%	**23.08%**
Other Degree	STAY	76.47%	68.57%	67.74%	70.27%	62.50%	**69.12%**
	PROM	69.23%	41.67%	42.86%	34.62%	20.00%	**41.49%**
Unknown Degree	STAY	46.15%	23.08%	30.56%	24.78%	40.44%	**34.08%**
	PROM	33.33%	33.33%	18.18%	17.86%	51.35%	**39.34%**
RACE							
White Officers	STAY	58.46%	53.47%	48.17%	43.74%	43.34%	**48.56%**
	PROM	63.74%	54.58%	58.48%	59.01%	63.07%	**59.89%**
Black Officers	STAY	53.06%	64.71%	59.09%	57.69%	61.68%	**60.00%**
	PROM	57.69%	45.45%	43.59%	48.89%	43.94%	**46.75%**
Officers with Other Races	STAY	57.33%	54.88%	54.76%	62.50%	45.88%	**54.77%**
	PROM	48.84%	66.67%	47.83%	57.78%	66.67%	**57.34%**
GENDER							
Female	STAY	39.36%	40.74%	34.48%	36.09%	33.33%	**35.97%**
	PROM	51.35%	39.39%	42.50%	50.82%	50.00%	**47.72%**
Male	STAY	61.37%	57.12%	52.87%	49.68%	49.56%	**53.67%**
	PROM	62.62%	56.23%	57.14%	58.97%	62.46%	**59.48%**
ACCESSION SOURCES							
OCS	STAY	66.67%	73.08%	66.95%	69.79%	64.48%	**67.79%**
	PROM	65.85%	51.75%	56.96%	60.98%	63.10%	**59.72%**
Other Sources	STAY	89.29%	75.36%	72.88%	54.17%	52.86%	**68.87%**
	PROM	78.00%	71.15%	72.09%	84.62%	59.46%	**72.60%**
ROTC Scholarship Program	STAY	55.44%	50.00%	38.24%	36.67%	32.79%	**41.13%**
	PROM	47.66%	47.96%	56.41%	52.73%	60.40%	**52.83%**
U.S. Naval Academy	STAY	47.03%	41.53%	36.73%	34.11%	37.39%	**39.38%**
	PROM	64.08%	56.12%	43.37%	47.95%	54.65%	**53.95%**
MARITAL STATUS							
Married Officers	STAY	68.77%	70.17%	62.77%	63.43%	59.66%	**64.55%**
	PROM	69.87%	63.16%	67.97%	70.16%	70.50%	**68.37%**
Single Officers	STAY	43.80%	37.70%	36.69%	30.79%	30.79%	**35.10%**
	PROM	44.25%	36.52%	33.59%	32.80%	39.10%	**37.12%**
DEPENDENTS							
No Dependents	STAY	41.42%	36.57%	37.99%	33.63%	35.51%	**36.79%**
	PROM	44.14%	37.17%	35.20%	41.74%	43.38%	**40.33%**
One or more dependent(s)	STAY	71.52%	71.55%	59.85%	56.70%	53.40%	**61.36%**
	PROM	69.70%	62.65%	66.24%	64.73%	68.73%	**66.40%**

NOTES:
1) STAY shows the retention rates by the end of tenth year in service, and PROM shows the promotion rates for the stayers for each demographic characteristics.
2) Some educational degrees were categorized as "unknown" in the original data set.

Table 4. Promotion and Retention Rates for the Full Sample.

		COHORT					
		1996	**1997**	**1998**	**1999**	**2000**	**TOTAL**
Number of Observations →		578	644	689	684	715	**3310**
DEPENDENT VARIABLES							
Officers Stayed		58.13%	55.75%	50.94%	50.44%	47.13%	**52.21%**
Officers Promoted (Out of Those Stayed)		61.90%	54.87%	56.70%	60.87%	62.31%	**59.26%**
PRIOR SERVICE STATUS							
Officers without Prior Service	STAY	49.70%	43.77%	39.66%	38.50%	37.59%	**41.39%**
	PROM	62.58%	54.43%	50.93%	62.80%	64.81%	**59.16%**
Officers with Prior Service	STAY	69.20%	71.02%	67.14%	70.16%	61.62%	**67.75%**
	PROM	61.27%	55.22%	61.58%	59.12%	60.00%	**59.35%**
EDUCATIONAL DEGREES							
Bachelor's Degree Owners	STAY	53.77%	49.90%	44.27%	44.00%	31.15%	**44.63%**
	PROM	58.30%	50.19%	52.99%	58.26%	42.04%	**53.22%**
Master's Degree Owners	STAY	95.45%	94.12%	94.29%	95.45%	95.83%	**95.19%**
	PROM	80.95%	81.25%	84.85%	88.89%	88.20%	**85.86%**
Doctorate Degree Owners	STAY	75.00%	50.00%	58.82%	40.74%	22.73%	**45.92%**
	PROM	66.67%	50.00%	10.00%	18.18%	0.00%	**31.11%**
First Professional Degree Owners	STAY	100.00%	100.00%	75.00%	75.00%	80.00%	**81.25%**
	PROM	100.00%	0.00%	0.00%	66.67%	0.00%	**23.08%**
Other Degree Owners	STAY	76.47%	68.57%	67.74%	70.27%	62.50%	**69.12%**
	PROM	69.23%	41.67%	42.86%	34.62%	20.00%	**41.49%**
RACE							
White Officers	STAY	58.52%	53.50%	49.10%	47.28%	44.86%	**50.29%**
	PROM	64.55%	54.62%	59.56%	62.07%	65.86%	**61.30%**
Black Officers	STAY	56.52%	65.85%	58.06%	61.19%	59.18%	**60.56%**
	PROM	57.69%	46.30%	47.22%	53.66%	41.38%	**47.91%**
Officers with Other Races	STAY	56.76%	59.21%	58.90%	66.15%	48.39%	**58.00%**
	PROM	47.62%	66.67%	46.51%	60.47%	73.33%	**58.13%**
GENDER							
Female	STAY	39.78%	41.25%	35.40%	37.68%	34.50%	**37.14%**
	PROM	51.35%	39.39%	42.50%	55.77%	52.54%	**49.32%**
Male	STAY	61.65%	57.80%	53.99%	53.66%	51.10%	**55.51%**
	PROM	63.21%	56.44%	58.52%	61.77%	64.39%	**60.72%**
ACCESSION SOURCES							
OCS	STAY	67.50%	75.33%	69.44%	76.77%	69.49%	**71.89%**
	PROM	66.67%	52.21%	58.67%	63.82%	66.67%	**61.39%**
Other Sources	STAY	88.46%	76.92%	80.77%	62.16%	55.36%	**73.28%**
	PROM	80.43%	72.00%	73.81%	86.96%	64.52%	**75.00%**
ROTC Scholarship Program	STAY	55.44%	50.26%	39.29%	38.78%	38.19%	**43.69%**
	PROM	47.66%	47.96%	57.14%	56.86%	62.89%	**54.26%**
U.S. Naval Academy	STAY	47.89%	41.88%	36.44%	36.56%	37.72%	**40.15%**
	PROM	64.71%	56.12%	43.90%	51.47%	54.65%	**54.82%**
MARITAL STATUS							
Married Officers	STAY	69.11%	70.81%	63.25%	67.72%	60.64%	**66.17%**
	PROM	69.91%	63.27%	69.82%	73.19%	72.37%	**69.64%**
Single Officers	STAY	43.82%	38.26%	38.17%	32.64%	32.15%	**36.60%**
	PROM	45.45%	36.84%	34.11%	34.55%	41.28%	**38.29%**
DEPENDENTS							
Having no dependent	STAY	41.54%	37.09%	38.85%	35.61%	37.79%	**38.13%**
	PROM	45.37%	37.50%	35.25%	45.45%	46.90%	**41.88%**
Having one or more dependent(s)	STAY	71.70%	72.22%	61.07%	60.59%	53.85%	**63.22%**
	PROM	69.74%	62.75%	68.12%	67.07%	70.09%	**67.46%**

NOTE:
STAY shows the retention rates by the end of tenth year in service, and PROM shows the promotion rates for the stayers for each demographic characteristics.

Table 5. Promotion and Retention Rates Excluding Officers with "Unknown Education" from the Full Sample.

C. DATA LIMITATIONS

The data used in this study have some limitations. First, some observations needed to be dropped due to missing commissioning dates. Furthermore, some variables, such as educational fields, could not be used in the regression models due to a high amount of missing information. Also there was no information about aptitude such as AFQT scores, fitness reports, or GPA scores that might have affected retention and promotion patterns.

IV. METHODOLOGY AND RESULTS

A. RESEARCH DESIGN

Our analysis estimates multivariate probit models to analyze the effects of advanced education on the retention and promotion of SWOs. Four different probit models are estimated for the retention and promotion outcomes: two that include officers with "unknown" education and two that delete officers with unknown education. In addition to estimation single stage probit models, we also estimate a two-step model that uses instrumental variables to adjust for selection bias due to unobserved factors that affect retention.

The dependent variables in this study are all binary variables. Estimating binary dependent variables by using linear probability models (LPM) has some drawbacks since "…the fitted probabilities can be less than zero or greater than one and the partial effect of any explanatory variable (appearing in level form) are constant" (Wooldridge, 2009, p. 575). Using a probit model overcomes these drawbacks and estimates the probability of the outcome (retention or promotion) in the following specification:

$$P(y = 1|\mathbf{x}) = P(y = 1|x_1, x_1, \ldots, x_k),$$

where y is the binary dependent variable and x represents the explanatory variables.

Since the goal of this study is to examine the effect of advanced education on the retention and promotion of officers, analyzing promotion for a sample of stayers from the full entry cohorts may cause biased estimation because there is no opportunity to observe those officers who separated prior to the promotion point. Officers who choose to leave prior to the promotion point may be positively or negatively selected. There may be unobservable factors that predict why individuals stay or leave the Navy and that are also correlated with promotion. All these possibilities needed to be addressed to avoid sample selection bias. Thus, in this study, the Heckman two-stage probit model with sample selection is used to adjust for the sample selection problem. In the Heckman two-stage probit model with sample

selection, the null hypothesis (H_0) states that there is no sample selection bias. The alternative hypothesis (H_1) is that there is a selection bias problem, and the results of the Heckman two-stage probit model with sample selection will test for and adjust for any bias in the estimated coefficients.

The Heckman two-stage probit model with sample selection needs at least one exogenous instrumental variable for the selection equation. In this study, "marital status" is chosen as the exogenous variable for the retention (selection) model. The reason for the use of "marital status" as an instrumental variable is that we believe single people more likely to change jobs frequently compared to married people, and because married people seek a more consistent lifestyle for their families. Wooldridge (2009) states that an instrumental variable is consistent when the endogenous variable for the selection model and error term are uncorrelated and endogenous variable and independent variables have any positive or negative correlation. Thus, in this study, although we don't know whether the "marital status" is valid and meets the condition for an instrumental variable, we will use it to provide an IV for the Heckman two-stage probit model.

Although this study focuses on the effect of advanced education on retention and promotion, other independent variables such as personal demographics, accession sources, and dependents are also included in the models to control for other factors that can affect these outcomes. In addition, the model includes dummies for each of the five cohorts in the sample to control for the unobserved characteristics that may change over time with each entering cohort.

The hypothesized effects of the variables for the retention and promotion models are shown in Table 6.

HYPOTHESIZED EFFECTS OF THE VARIABLES

	Officers with Prior Service	Master's Degree Holders	Doctorate Degree Holders	First Professional Degree Holders	Other Degree Holders	Unknown Degree Holders	Black Officers	Officers with Other Races	Female	Other Sources	ROTC Scholarship Program	U.S. Naval Academy	Married Officers	No Dependents
Retention	+	+	-	-	+	UNK	+	UNK	-	-	+	+	+	-
Promotion	+	+	+	+	-	UNK	UNK	UNK	+	-	+	+	NI	-

NOTES:
1) Reference groups: Baccalaureate degree recipients, white officers, males, from OCS, single officers, and having one or more dependents.
2) UNK: Unknown.
3) NI: Not included.

Table 6. Hypothesized Effects of the Variables.

Officers with prior service are predicted to stay and be promoted at higher rates. They have extensive prior military service and are likely to have stronger tastes for the military.

Although Branigan (2001) and Kahraman (2007) estimate that Doctorate degree recipients are more likely to stay in the military as compared to those with Bachelor's degree, this study hypothesizes the opposite effect because we believe that there are more civilian opportunities for Doctorate degree holders. Although they are less likely to stay in service they are more likely to be promoted if they do stay. For Master's degree holders, we hypothesize the same effect as in the previous studies by Conzen (1999), Branigan (2001), and Kahraman (2007). We believe that officers who pursue Master's degrees are generally enthusiastic and ambitious personnel who want to stay and be promoted. First Professional degrees include fields such as law, education, medicine, pharmacy, or dentistry. Officers with those degrees can find good civilian jobs, and their probability of leaving is predicted to be higher than for those with only a Bachelor's degree. However, if they stay, it is thought that they will be more likely to be promoted.

We believe that black officers are more likely to stay in service since civilian career opportunities may be less available for them due to higher civilian unemployment rates. Due to the arduousness of military occupations, we believe that female officers are less likely to stay compared to male officers. This hypothesis is consistent with Celik and Karakaya's (2011) study. However, contrary to their study, we expect higher promotion rates for female officers, which is consistent with Bowman and Mehay's (1999) results. We also think that married officers and officers with dependents are more likely to stay because they do not want to take the risks that may be associated with giving up steady jobs with good pay and benefits.

Lastly, for the accession sources, ROTC Scholarship and USNA graduates are predicted to be more likely promoted than OCS graduates. This is based on Bowman and Mehay (1999), who find that promotion probabilities for USNA graduates are significantly higher than other accession sources. They also indicate that "…USNA graduates enter the Navy with a greater stock of human capital and possibly affective skills." Thus, we also think that retention rates for USNA graduates are higher than those for OCS graduates. We also anticipate the same effects for ROTC scholarship program graduates as for USNA graduates, but except negative effects for officers from other sources.

As an additional model to this study, another probit model is specified to estimate the effects of demographic variables on obtaining advanced degrees. The goal of this model is to determine whether demographic characteristics are associated with acquiring advanced educational degrees. The reason this question is posed is because we are interested in knowing what factors drive officers to obtain advanced degrees. This is important because we are concerned that educational attainment is an endogenous regressor in the retention and promotion models. If educational attainment is endogenous, then we cannot interpret its coefficient as the causal effect of education on retention and promotion. Therefore, we want to see what percent of advanced education is explained by these demographic variables.

Lastly, we create another simple probit model, where advanced education is the binary dependent variable. The reason to create this model is to analyze for the effects of the same independent variables on advanced education, by using the sample that includes stayers only. Later on, we run a bivariate probit model to adjust for sample selection bias.

B. MULTIVARIATE ANALYSIS

1. Probit Retention Model

a. Full Sample (Including Those with "Unknown Education" Category)

The basic retention model is specified using all the variables depicted in Table 1 in Chapter III:

(1a) $$(STAY) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(MASTdeg)_i + \beta_3(DOCTdeg)_i + \beta_4(FPROdeg)_i + \beta_5(OTHERdeg)_i + \beta_6(UNKNdeg)_i + \beta_7(BLACK)_i + \beta_8(OTHERrace)_i + \beta_9(FEMALE)_i + \beta_{10}(ROTCsch)_i + \beta_{11}(USNA)_i + \beta_{12}(OTHERsource)_i + \beta_{13}(MARRIED)_i + \beta_{14}(NOdep)_i + \beta_{15}(ENTRY1997)_i + \beta_{16}(ENTRY1998)_i + \beta_{17}(ENTRY1999)_i + \beta_{18}(ENTRY2000)_i + u_i$$

The reference categories for the binary variables include those who are non-prior service officers, whites, males, those with Baccalaureate only degrees, OCS graduates, single, with dependent(s), and entered in 1996. The reason for including year dummies in this model and in the following models is that the data set used in this study is panel data. "A panel data (or longitudinal data) set consists of a time series for each cross-sectional member in the data set" (Wooldridge, 2009, p. 10). The data set used in this study, thus, includes observations for the officers throughout the years. Therefore, we use year dummies and "…allow the intercept to differ across the time periods to reflect the fact that the population may have different distributions in different time periods" (Wooldridge, 2009, p. 445).

The goal of this model is to answer two questions:

1) What is the effect of advanced education on the retention of Navy SWOs?

2) What factors, other than education, affect the retention decision of SWOs?

Table 7 shows the results from estimation of the probit retention model (1a) (for the full probit results see Appendix A). The p-value indicates the model is highly significant and at least one of the independent variables explains the dependent

variable for retention. The pseudo R square shows that the independent variables explain 20.4% of the variation in retention.

The results in Table 7 indicate that officers with prior service have a retention probability (until the end of the tenth year) that is 16 percentage points higher than those with no prior service. This result is significant at the 1% level. This is not a surprising result because an officer with prior service has already indicated his/her desire to stay.

In the Table 7 the retention effect of education varies by type of degree. Officers with Master's degrees have a probability to stay that is 48.5 percentage points higher than officers with Baccalaureate only degrees. This result is significant at 1% level. However, the result for Master's degree holders is implausibly high (109% greater retention rate compared to Bachelor's degree holders). One possible reason for the size of this coefficient is that there might be bias in the estimation. A second reason is that institutional factors affect the coefficient: those who accept funded graduate program incur an additional service obligation up to three years. The graduate education period plus the obligatory service period sum up to five years which helps explain the reason for the exaggerated marginal effect. Wielsma (1996) also reached similar results: "…graduate education appeared to have a positive effect on promotion; however, failure to correct for retention and selection issues biased the estimated effects of graduate education upward."

Doctorate degree holders stay at lower rates than Baccalaureate degree holders (21.9 percentage points lower), while those with First Professional degrees stay at higher rates than Baccalaureate degree holders (20.7 percentage points higher). Compared to Baccalaureate degree holders, other degree holders are slightly more likely to stay while "unknown" degree holders are less likely to stay (by 14.9 percentage points). For advanced education holders, estimation results are very similar to our hypothesized effects. The effects of Master's degrees and Doctorate degrees on retention are similar to the results in Conzen's (1999) study. Moreover, our results are consistent with Branigan's (2001) results, except that for the Doctorate degree. Also, except for the Doctorate degree, Kahraman (2007) reached similar results for the effect of Master's and First Professional degrees. The reason for the difference in the Doctorate degree effect between this study and prior studies might be

due to the increase in job opportunities for Doctorate degree holders in civilian companies between 2000 and 2011.

Black officers have a retention probability that is 6.1 percentage points higher than white officers (significant at the 5% level). Officers grouped in other races have a probability to stay that is 9 percentage points higher than white officers (significant at the 1% level).

Female officers have a retention probability (to the promotion point in the tenth year) that is 8.1 percentage points lower than male officers (significant at the 1% level). Compared to single officers, married officers stay at higher rates by 22.2 percentage points (significant at the 1% level). The estimates indicate that officers with no dependents have a retention probability that is 3.7 percentage points higher than those with one or more dependents, although the coefficient is insignificant. We can conclude that female or single officers are less likely to stay in service up to the promotion point, compared to male or married officers, respectively. Getting a negative effect for officers with dependents is not what we expected, because we think that dependents make officers continue in their jobs for more regular and stable lives.

Compared to OCS graduates, ROTC graduates are less likely to stay (by 17.7 percentage points). USNA graduates have a retention probability that is 21.3 percentage points lower than OCS graduates (significant at the 1% level), while officers from other sources are more likely to stay (by 7.3 percentage points significant at the 5% level). In short, retention probability for OCS graduates is higher than for USNA or ROTC graduates, while it is lower than for officers from other sources. In our hypothesis, we expect to get positive effect for the retention of USNA graduates; surprisingly, the results indicate that they are less likely to stay in service than OCS graduates.

Officers are grouped under cohorts based on their commissioning dates. The 1997 entrants have a retention probability that is 5.1 percentage points lower than 1996 entrants (significant at the 10% level). The estimates indicate that 1998 entrants are less likely to stay than 1996 entrants (by 9.9 percentage points; significant at the 1% level). The 1999 entrants have a probability to stay that is 8.3 percentage points lower than 1996 entrants, while 2000 entrants have a retention

probability that is 16.7 percentage points lower than 1996 entrants. Both probabilities are significant at the 1% level. It is obvious from the results that retention probability decreases by years; furthermore, there is a huge difference between the retention probabilities of 1999 and 2000 entrants. It can be predicted that, officers who are in service during the beginning of The Global War on Terror are more likely to leave active duty after their obligatory service time (four or five years) ends. Thus, the 2003 Iraq War might have had a negative effect on retention rates.

RETENTION MODEL ESTIMATIONS		
	COEFFICIENTS	MARGINAL EFFECTS
VARIABLES	STAY	STAY
Officers with prior service	0.4054***	0.1595***
	(0.0561)	(0.0217)
Master's degree	1.6726***	0.4845***
	(0.1153)	(0.0163)
Doctorate degree	-0.5665***	-0.2192***
	(0.1400)	(0.0502)
First Professional degree	0.5599	0.2072*
	(0.3639)	(0.1186)
Other degree	0.0437	0.0174
	(0.1253)	(0.0496)
Unknown degree	-0.3764***	-0.1489***
	(0.0833)	(0.0322)
Black	0.1540**	0.0608**
	(0.0775)	(0.0303)
Other races	0.2298***	0.0902***
	(0.0735)	(0.0283)
Female	-0.2029***	-0.0808***
	(0.0614)	(0.0244)
ROTC Scholarship	-0.4461***	-0.1765***
	(0.0676)	(0.0263)
USNA	-0.5400***	-0.2128***
	(0.0689)	(0.0264)
Other sources	0.1853*	0.0729**
	(0.0950)	(0.0368)
Married	0.5641***	0.2216***
	(0.0723)	(0.0277)
No dependents	0.0938	0.0373
	(0.0750)	(0.0297)
1997 Cohort	-0.1275*	-0.0508*
	(0.0772)	(0.0308)
1998 Cohort	-0.2483***	-0.0988***
	(0.0756)	(0.0300)
1999 Cohort	-0.2095***	-0.0834***
	(0.0753)	(0.0299)
2000 Cohort	-0.4226***	-0.1673***
	(0.0759)	(0.0295)
Constant	-0.0458	
	(0.1084)	
Observations	**3,668**	**3,668**
Overall Sample Retention Rate (%)	**50.44**	
Likelihood Ratio Chi Square	**1034.5**	
Standard errors in parentheses		
***** p<0.01, ** p<0.05, * p<0.1**		

Table 7. Probit Retention Model (Full Sample)

b. Sample Excluding Those with "Unknown Education" from the Full Sample

For some officers in the data set, educational attainment is listed as "unknown." In model (1a), we estimated a simple probit regression including officers in the "unknown" education categories. However, it is obvious in Table 2 (Chapter III) that, especially for 1999 and 2000 cohorts, the number of those with "unknown" education is unexpectedly high, thus lowering the Baccalaureate and Master's degree rates significantly. Therefore, we also estimate our models after excluding officers with unknown education to see how this might affect the estimated effects of our advanced education variation. The model is specified below:

(1b) $$(STAY) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(MASTdeg)_i + \beta_3(DOCTdeg)_i + \beta_4(FPROdeg)_i + \beta_5(OTHERdeg)_i + \beta_6(BLACK)_i + \beta_7(OTHERrace)_i + \beta_8(FEMALE)_i + \beta_9(ROTCsch)_i + \beta_{10}(USNA)_i + \beta_{11}(OTHERsource)_i + \beta_{12}(MARRIED)_i + \beta_{13}(NOdep)_i + \beta_{14}(ENTRY1997)_i + \beta_{15}(ENTRY1998)_i + \beta_{16}(ENTRY1999)_i + \beta_{17}(ENTRY2000)_i + u_i$$

The reference categories for the binary variables include those, who are non-prior service officers, whites, males, those with Baccalaureate degrees, OCS graduates, singles, with dependent(s), and entered in 1996. The sample size is reduced to 3,310 officers from 3,668 officers, after excluding those with "unknown" education.

Table 8 presents the results for retention analysis excluding unknown degrees (for the full probit results see Appendix B). There are no big differences between the two multivariate model estimations, and coefficients of the variables are very similar in magnitude.

Officers with prior service have a retention probability that is 14.8 percentage points higher than those with no prior service. It was 16 percentage points higher in probit estimation including the unknown education category.

For the educational degrees, Master's degree holders have a probability to stay that is 47.8 percentage points higher than Bachelor's degree holders. This probability was 48.5 percentage points higher in probit estimation including the unknown education category. The result for Master's degree holders is still

implausibly high. The results are either biased or still exhibit the institutional effects, and we still expect the Heckman two-stage probit model with sample selection correct for this selection bias, in model (3b). Doctorate degree holders have a retention probability that is 20.8 percentage points lower than Bachelor's degree holders, while it was 21.9 percentage points lower in probit estimation including unknown education category. Officers with First Professional degrees are more likely to stay (by 21.9 percentage points) until the promotion point in the tenth year of service than Bachelor's degree holders, and this probability was 20.7 percentage points higher in probit estimation including the unknown education category. Other degree holders have a retention probability that is 2.9 percentage points higher than Bachelor's degree holders. This probability was 1.7 percentage points higher than Bachelor's degree holders in probit estimation including the unknown education category. All of these coefficients are significant in both models except for other degree holders.

Black officers have a retention probability that is 5.8 percentage points higher than white officers. This probability was 6.1 percentage points higher than white officers in probit estimation including the unknown education category. Other races have a probability to stay that is 10.2 percentage points higher than whites, while it was 9 percentage points higher than whites in probit estimation including the unknown education category.

Female officers have a retention probability that is 8.5 percentage points lower than male officers. This probability was 8.1 percentage points lower than male officers in probit estimation including the unknown education category. Married officers have a probability to stay that is 21.9 percentage points higher than single officers. In probit estimation including the unknown education category, married officers stay at higher rates than single officers (22.2 percentage points). Officers with no dependents have a retention probability that is 3.3 percentage points higher than officers having dependents. This probability was 3.7 percentage points in probit estimation including the unknown education category.

The ROTC scholarship graduates stay at lower rates than OCS graduates (15.5 percentage points lower). This effect was 17.7 percentage points lower in probit estimation including the unknown education category. The USNA graduates have a probability to stay that is 19.5 percentage points lower than OCS graduates, while this effect was 21.3 percentage points lower in probit estimation

including the unknown education category. Officers from other sources have a retention probability that is 10.2 percentage points higher than OCS graduates. This effect in probit estimation including the unknown education category was 7.3 percentage points higher.

The 1997 entrants have a retention probability that is 4.5 percentage points lower than 1996 entrants. In probit estimation including the unknown education, 1997 entrants were less likely to stay than 1996 entrants (by 5.1 percentage points). The 1998 entrants have a probability to stay that is 9.1 percentage points lower than 1996 entrants. In probit estimation including unknown education, 1998 entrants were less likely to stay than 1996 entrants by 9.9 percentage points. The 1999 entrants have a retention probability that is 7.4 percentage points lower than 1996 entrants. In probit estimation including the unknown education, 1999 entrants were less likely to stay than 1996 entrants (by 8.3 percentage points). Lastly the 2000 entrants have a probability to stay that is 19.2 percentage points lower than 1996 entrants. This probability was 16.7 percentage points lower in probit estimation including unknown education category.

RETENTION MODEL ESTIMATIONS		
	COEFFICIENTS	MARGINAL EFFECTS
VARIABLES	STAY	STAY
Officers with prior service	0.3784***	0.1479***
	(0.0595)	(0.0229)
Master's degree	1.7006***	0.4779***
	(0.1157)	(0.0157)
Doctorate degree	-0.5292***	-0.2075***
	(0.1410)	(0.0526)
First Professional degree	0.6153*	0.2197**
	(0.3647)	(0.1099)
Other degree	0.0746	0.0293
	(0.1261)	(0.0492)
Black	0.1488*	0.0582*
	(0.0815)	(0.0314)
Other races	0.2646***	0.1022***
	(0.0786)	(0.0294)
Female	-0.2147***	-0.0853***
	(0.0649)	(0.0258)
ROTC Scholarship	-0.3932***	-0.1554***
	(0.0725)	(0.0284)
USNA	-0.4955***	-0.1954***
	(0.0728)	(0.0282)
Other sources	0.2637**	0.1017***
	(0.1050)	(0.0392)
Married	0.5614***	0.2194***
	(0.0762)	(0.0291)
No dependent(s)	0.0831	0.0328
	(0.0790)	(0.0311)
1997 Cohort	-0.1142	-0.0453
	(0.0781)	(0.0311)
1998 Cohort	-0.2286***	-0.0908***
	(0.0770)	(0.0306)
1999 Cohort	-0.1863**	-0.0740**
	(0.0778)	(0.0309)
2000 Cohort	-0.4870***	-0.1924***
	(0.0794)	(0.0308)
Constant	-0.0727	
	(0.1135)	
Observations	**3,310**	**3,310**
Overall Sample Retention Rate (%)	**52.21**	
Likelihood Ratio Chi Square	**935.02**	
Standard errors in parentheses		
***** p<0.01, ** p<0.05, * p<0.1**		

Table 8. Probit Retention Model (Excludes Officers with “Unknown Education”).

2. Probit Promotion Model

a. Full Sample (Including Those with "Unknown Education")

The base promotion model is built by using all the variables depicted in Table 1 in Chapter III, and is specified as follows:

(2a) $$(PROMOTE) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(MASTdeg)_i + \beta_3(DOCTdeg)_i + \beta_4(FPROdeg)_i + \beta_5(OTHERdeg)_i + \beta_6(UNKNdeg)_i + \beta_7(BLACK)_i + \beta_8(OTHERrace)_i + \beta_9(FEMALE)_i + \beta_{10}(ROTCsch)_i + \beta_{11}(USNA)_i + \beta_{12}(OTHERsource)_i + \beta_{13}(NOdep)_i + \beta_{14}(ENTRY1997)_i + \beta_{15}(ENTRY1998)_i + \beta_{16}(ENTRY1999)_i + \beta_{17}(ENTRY2000)_i + u_i$$

Reference categories for the binary variables in the promotion model includes those, who are non-prior service officers, whites, males, those with Baccalaureate degrees, OCS graduates, with one or more dependents, and entered in 1996.

With this promotion model, we aim to answer two questions:

1) What is the effect of advanced education on the probability of being promoted to O-4 for Navy SWOs?

2) What factors, other than education level, affect the promotion of SWOs?

Table 9 shows the results from the probit estimation of model (2a) (for the full probit results see Appendix C). The p-value of the model is zero; thus, the model is highly significant and at least one of the independent variables explains the dependent variable. The pseudo R square shows that the independent variables explain 13.9% of the variation in promotion.

The results in Table 9 indicate that officers with prior service have a promotion probability that is 0.7 percentage points higher than for those with no prior service. However; this result is insignificant.

Officers with Master's degrees have a promotion probability that is 31.6 percentage points higher than officers with Baccalaureate degrees (significant at the 1% level). As in the previous retention models, the coefficient for Master's degree

holders is high (59% higher promotion rate compared to Bachelor's degree holders). However, the result more likely indicates the true difference in promotion and job performance for those with Master's degrees. Additionally, if the estimations are biased, we expect the Heckman two-stage probit model with sample selection to correct for this selection bias. The Heckman model is estimated in model (3a). Doctorate degree holders and First Professional degree holders are less likely to be promoted than Bachelor's degree holders. Other degree holders have a promotion probability that is 20.6 percentage points lower than the Baccalaureate degree holders (significant at 1% level). Lastly, those with unknown degrees have a promotion probability that is 17 percentage points lower than Bachelor's degree holders. Surprisingly, the results are different from what we hypothesized for Doctorate degree and First Professional degree holders. Comparing other studies, Bowman and Mehay (1999) found that officers with graduate degrees are more likely to be promoted. Branigan (2001) and Kahraman (2007) also find similar results similar to those of Bowman and Mehay (1999).

The estimates indicate that black officers have a promotion probability that is 13.5 percentage points lower than white officers, while probability for the officers of other races is slightly higher than white officers (by 0.4 percentage points, and insignificant). The effect of gender on promotion is insignificant and having no dependents reduces the likelihood of promotion by 23.8 percentage points compared to the officers with one or more dependents.

Compared to OCS graduates, ROTC scholarship graduates are promoted at lower rates (7.3 percentage points lower). USNA graduates have a probability to be promoted that is 1.4 percentage points lower than OCS graduates, while officers from other sources have a promotion probability that is 18 percentage points higher than OCS graduates.

Among all cohorts, 1997 entrants have a promotion probability that is 8.2 percentage points lower than 1996 entrants (significant at the 5% level). The 1998 entrants are promoted at lower rates than 1996 entrants, while 1999 entrants have a probability to be promoted that is 2.1 percentage points lower than 1996 entrants. Lastly, 2000 entrants have a promotion probability that is 5.6 percentage points lower than 1996 entrants.

PROMOTION MODEL ESTIMATIONS		
	COEFFICIENTS	MARGINAL EFFECTS
VARIABLES	PROMOTE	PROMOTE
Officers with prior service	0.0179	0.0070
	(0.0748)	(0.0290)
Master's degree	0.9245***	0.3160***
	(0.0913)	(0.0254)
Doctorate degree	-0.9052***	-0.3434***
	(0.2146)	(0.0700)
First Professional degree	-0.9479**	-0.3560***
	(0.4337)	(0.1357)
Other degree	-0.5218***	-0.2058***
	(0.1491)	(0.0576)
Unknown degree	-0.4287***	-0.1695***
	(0.1353)	(0.0532)
Black	-0.3422***	-0.1350***
	(0.0975)	(0.0386)
Other races	0.0107	0.0042
	(0.0979)	(0.0378)
Female	0.0097	0.0037
	(0.0960)	(0.0371)
ROTC Scholarship	-0.1866**	-0.0729**
	(0.0872)	(0.0343)
USNA	-0.0356	-0.0138
	(0.0957)	(0.0372)
Other sources	0.4963***	0.1786***
	(0.1129)	(0.0367)
No dependents	-0.6101***	-0.2375***
	(0.0724)	(0.0277)
1997 Cohort	-0.2086**	-0.0818**
	(0.1003)	(0.0396)
1998 Cohort	-0.1762*	-0.0690*
	(0.1016)	(0.0401)
1999 Cohort	-0.0532	-0.0207
	(0.1016)	(0.0396)
2000 Cohort	-0.1428	-0.0557
	(0.1059)	(0.0416)
Constant	0.4766***	
	(0.1119)	
Observations	**1,850**	**1,850**
Overall Sample Promotion Rate (%)	**57.95**	
Likelihood Ratio Chi Square	**350**	
Standard errors in parentheses		
***** p<0.01, ** p<0.05, * p<0.1**		

Table 9. Probit Promotion Model (Full Sample)

b. Sample Excluding Those with "Unknown Education" from the Full Sample

For the promotion analysis excluding unknown education category, the base model is specified as follows:

(2b) $$(PROMOTE) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(MASTdeg)_i + \beta_3(DOCTdeg)_i + \beta_4(FPROdeg)_i + \beta_5(OTHERdeg)_i + \beta_6(BLACK)_i + \beta_7(OTHERrace)_i + \beta_8(FEMALE)_i + \beta_9(ROTCsch)_i + \beta_{10}(USNA)_i + \beta_{11}(OTHERsource)_i + \beta_{12}(NOdep)_i + \beta_{13}(ENTRY1997)_i + \beta_{14}(ENTRY1998)_i + \beta_{15}(ENTRY1999)_i + \beta_{16}(ENTRY2000)_i + u_i$$

Reference categories for the binary variables in the promotion model includes those, who are non-prior service officers, whites, males, those with Baccalaureate degrees, OCS graduates, with one or more dependents, and entered in 1996. The sample size is reduced to 1,728 officers from 1,850 officers.

Table 10 presents the results for promotion analysis without unknown degrees (for the full probit results see Appendix D). There are no big differences between the two multivariate model estimations, and coefficients of the variables are close.

Officers with prior service are promoted at lower rates compared to non-prior service officers (by 1.6 percentage points). This probability was 0.7 percentage points higher than non-prior service officers in probit estimation including those with unknown education. However, both coefficients are insignificant.

Master's degree holders have a promotion probability that is 32.4 percentage points higher than Bachelor's degree holders, while it was 31.6 percentage points higher than Bachelor's degree holders in probit estimation including those with unknown education. The result for Master's degree holders is still high (61% more promotion rate compared to Bachelor's degree holders). Again, the result more likely indicates a true difference in promotion and job performance for those with Master's degrees. If the estimations are biased, we expect the Heckman two-stage probit model correct for this selection bias in model (3a). Doctorate degree holders are promoted at lower rates than Bachelor's degree holders (33.6 percentage points lower). This probability was 34.4 percentage points lower than Bachelor's degree holders in probit

estimation including those with unknown education. First Professional degree holders have a probability to be promoted that is 34.2 percentage points lower than Bachelor's degree holders, and this probability was 35.6 percentage points lower in probit estimation including those with unknown education. There is a 1.4-percentage-point difference between the two analyses. Other degree holders have a promotion probability that is 19.3 percentage points lower than Bachelor's degree holders. It was 20.6 percentage points less than Bachelor's degree holders in probit estimation including those with unknown education. All of these coefficients are significant in both models.

Black officers have a promotion probability that is 12.2 percentage points lower than white officers. This probability was 13.5 percentage points lower than white officers in probit estimation including those with unknown education. Officers with other races are promoted at lower rates than white officers (0.1 percentage point lower), while it was 0.4 percentage point higher than white officers in probit estimation including those with unknown education.

Female officers are promoted at higher rates than male officers (0.4 percentage point higher). This probability is the same as the probability in probit estimation including the unknown education category. Officers without dependents have a promotion probability that is 23.3 percentage points lower than officers with dependents. This probability was 23.8 percentage points lower than officers with dependents in probit estimation including those with unknown education.

The ROTC scholarship program graduates are promoted at lower rates than OCS graduates (5.4 percentage points lower). It was 7.3 percentage points lower than OCS graduates in probit estimation including those with unknown education. USNA graduates have a probability to be promoted that is 0.1 percentage point lower than OCS graduates, while this probability was 1.4 percentage points lower than OCS graduates in probit estimation including those with unknown education. Officers from other sources are promoted at higher rates than OCS graduates (19.7 percentage points higher). This probability in probit estimation including those with unknown education was 17.9 percentage points.

The 1997 entrants have a probability to be promoted that is 8.4 percentage points lower than 1996 entrants. In probit estimation including those with

unknown education, 1997 entrants were less likely to be promoted than 1996 entrants by 8.2 percentage points. The 1998 entrants are promoted at lower rates than the 1996 entrants (6.4 percentage points lower). In probit estimation including those with unknown education, 1998 entrants were less likely to be promoted than 1996 entrants by 6.9 percentage points. The 1999 entrants have a probability to be promoted that is 0.6 percentage point lower than 1996 entrants. In probit estimation including those with unknown education, 1999 entrants were less likely to be promoted than 1996 entrants by 2.1 percentage points. Lastly, 2000 entrants are promoted at lower rates than 1996 entrants (9.6 percentage points lower). This probability was 5.6 percentage points lower than 1996 entrants in probit estimation including those with unknown education.

The most significant changes in the coefficients are observed for ROTC scholarship program graduates (by 1.9 percentage points) and the 2000 cohort (by 4 percentage points). However, the coefficient for ROTC scholarship program graduates is insignificant in this analysis, while the coefficient for the 2000 cohort is significant at 5% level.

PROMOTION MODEL ESTIMATIONS		
	COEFFICIENTS	**MARGINAL EFFECTS**
VARIABLES	**PROMOTE**	**PROMOTE**
Officers with prior service	-0.0408	-0.0156
	(0.0782)	(0.0300)
Master's degree	0.9665***	0.3240***
	(0.0923)	(0.0250)
Doctorate degree	-0.8752***	-0.3355***
	(0.2155)	(0.0732)
First Professional degree	-0.8975**	-0.3422**
	(0.4376)	(0.1450)
Other degree	-0.4882***	-0.1925***
	(0.1497)	(0.0587)
Black	-0.3106***	-0.1218***
	(0.1014)	(0.0402)
Other races	-0.0037	-0.0014
	(0.1016)	(0.0390)
Female	0.0106	0.0041
	(0.1001)	(0.0383)
ROTC Scholarship	-0.1400	-0.0541
	(0.0894)	(0.0348)
USNA	-0.0032	-0.0012
	(0.0980)	(0.0376)
Other sources	0.5642***	0.1967***
	(0.1193)	(0.0364)
No dependent(s)	-0.6015***	-0.2330***
	(0.0752)	(0.0288)
1997 Cohort	-0.2156**	-0.0839**
	(0.1011)	(0.0397)
1998 Cohort	-0.1642	-0.0637
	(0.1029)	(0.0403)
1999 Cohort	-0.0164	-0.0063
	(0.1039)	(0.0400)
2000 Cohort	-0.2463**	-0.0960**
	(0.1100)	(0.0433)
Constant	0.4736***	
	(0.1144)	
Observations	**1,728**	**1,728**
Overall Sample Promotion Rate (%)	**59.26**	
Likelihood Ratio Chi Square	**322.88**	
Standard errors in parentheses		
***** p<0.01, ** p<0.05, * p<0.1**		

Table 10. Probit Promotion Model (Excludes Officers with “Unknown Education”).

3. Heckman Two-Stage Probit Model with Sample Selection Analysis

a. Full Sample (Including Those with "Unknown Education" Category)

The Heckman two-stage probit model with sample selection is specified by using all the variables depicted in Table 1 in Chapter III. Wooldridge (2009) defines the Heckman two-stage probit model with sample selection as:

$$y = x\beta + u,\ E(u|x) = 0$$

$$s = 1[\ z\gamma + v \geq 0\ ],$$

where

y = promotion model dependent variable

x = all independent variables in both models

s = retention model dependent variable (selection model)

z = instrumental variable

u = error term for the promotion model

v = error term for the retention model

Thus, the two stage model is shaped as follows:

(3a) $(PROMOTE) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(MASTdeg)_i + \beta_3(DOCTdeg)_i + \beta_4(FPROdeg)_i + \beta_5(OTHERdeg)_i + \beta_6(UNKNdeg)_i + \beta_7(BLACK)_i + \beta_8(OTHERrace)_i + \beta_9(FEMALE)_i + \beta_{10}(ROTCsch)_i + \beta_{11}(USNA)_i + \beta_{12}(OTHERsource)_i + \beta_{13}(NOdep)_i + \beta_{14}(ENTRY1997)_i + \beta_{15}(ENTRY1998)_i + \beta_{16}(ENTRY1999)_i + \beta_{17}(ENTRY2000)_i + u_i$

$(STAY) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(MASTdeg)_i + \beta_3(DOCTdeg)_i + \beta_4(FPROdeg)_i + \beta_5(OTHERdeg)_i + \beta_6(UNKNdeg)_i + \beta_7(BLACK)_i + \beta_8(OTHERrace)_i + \beta_9(FEMALE)_i + \beta_{10}(ROTCsch)_i + \beta_{11}(USNA)_i + \beta_{12}(OTHERsource)_i + \beta_{13}(MARRIED)_i + \beta_{14}(NOdep)_i + \beta_{15}(ENTRY1997)_i + \beta_{16}(ENTRY1998)_i + \beta_{17}(ENTRY1999)_i + \beta_{18}(ENTRY2000)_i + u_i.$

With the Heckman two-stage probit model with sample selection, we aim to adjust for selection bias created by the officers who chose to leave prior to the

promotion point. The Heckman two-stage probit model with sample selection uses the same 3,668 officers, of whom 1,818 are censored and 1,850 are uncensored. Those 1,818 censored observations are the officers who left before the end of the tenth year in service. The 1,850 uncensored observations represent those officers who stayed until the end of the tenth year in service. Table 11 shows the estimation results for the Heckman two-stage probit model with sample selection.

The Wald Test for the Heckman two-stage probit model indicates that the correlation coefficient between error terms is highly significant (Prob>chi square = 0.00), and implies that we can reject the null hypothesis (H_0: there is no sample selection bias), and conclude that there is selection bias. Rho (rho = -0.8988) shows that the error terms in the two models are negatively correlated (see Appendix E for the full results).

The results in the Table 11 show that officers with prior enlisted service have a promotion probability that is 18.2 percentage points lower than that of non-prior service officers, contrary to the results in the simple probit regression estimation. The coefficient of prior service is negative and significant at 1% level, while it was positive and insignificant in the simple probit estimation.

Compared to Bachelor's degree holders, Master's degree holders have a promotion probability that is 36.1 percentage points higher. The coefficient is significant at the 1% level. In simple probit regression, the promotion probability for Master's degree holders was 31.6 percentage points higher than for Baccalaureate degree holders. This marginal effect means that the promotion rate for those with MAs is 68% higher than for Bachelor's degree holders. One explanation for the high promotion rate is that those with MA degrees have better job performance than those with BA's. Doctorate degree holders are promoted at lower rates than Baccalaureate degree holders (43 percentage points lower; significant at the 5% level). This promotion probability was 34.3 percentage points lower for MAs in the simple probit regression.

For the First Professional degree holders, there is a huge difference between the simple probit model and the Heckman two-stage probit model. First Professional degree holders have a promotion probability that was 35.6 percentage points lower compared to Baccalaureate degree holders in the simple probit

estimation. However, the promotion probability is 95.2 percentage points lower in the Heckman two-stage probit model (significant at the 1% level).

Black officers are promoted at lower rates than white officers (31 percentage points lower; significant at the 1% level). In the simple probit model, this probability was 13.5 percentage points lower. Other race officers also have lower promotion probabilities. In the Heckman two-stage probit model, officers with other races have promotion probabilities that are 8.5 percentage points (insignificant) lower than white officers.

Both the simple probit model and the Heckman two-stage probit model have insignificant coefficients for female officers.

In Table 11, the ROTC scholarship graduates have a promotion probability that is 5.6 percentage points higher than OCS graduates, but the coefficient is insignificant. By contrast, in the simple probit model the promotion probability for ROTC scholarship graduates was 7.3 percentage points lower than for OCS graduates. USNA graduates are more likely to be promoted than OCS graduates (by 19.4 percentage points; significant at 5% level), whereas they were less likely to be promoted than OCS graduates (by 3.6 percentage points) in the simple probit models. Officers from other sources are more likely to be promoted than OCS graduates, by 28.7 percentage points (significant at 1% level).

In Table 11, the Heckman two-stage probit model results show that officers with no dependents have a promotion probability that is 22.1 percentage points lower than officers with one or more dependents (significant at the 1% level). For the cohort dummies, none of them are statically significant.

The instrumental variable (marital status) is statically significant in the retention model. However, the IV is probably too weak to predict the ultimate outcome. As Wooldridge (2009) explains how an IV can be used to solve the sample selection problem in model of this type.

Let z be an observable variable with the following two properties:

1) Cov (z, u) = 0 (z is uncorrelated with the omitted variable u, in the retention model),

2) Cov (x, z) ≠ 0 (z is strongly correlated with the endogenous variable **x**, in the promotion model),

then z is an suitable IV. However, if the IV does not fulfill these requirements thoroughly, “z” is said to be a weak IV. “A weak instrumental variable causes the estimation be biased and be too large in magnitude” (Wooldridge, 2009, p. 514). In this study, thus, we can see the effect of a weak IV in the results as the coefficient on Master’s degree balloons in Table 11. Although the Heckman two-stage probit model with sample selection corrects for the sample selection bias, we cannot reach unbiased results due to the weak IV in the study.

HECKMAN PROBIT MODEL WITH SAMPLE SELECTION		
VARIABLES	**MARGINAL EFFECTS PROMOTE**	**MARGINAL EFFECTS STAY**
Officers with prior service	-0.1822***	0.3973***
	(0.0637)	(0.0556)
Master's degree	0.3612***	1.6842***
	(0.0900)	(0.1150)
Doctorate degree	-0.4300**	-0.5833***
	(0.1761)	(0.1388)
First Professional degree	-0.9523***	0.5115
	(0.3574)	(0.3559)
Other degree	-0.4366***	0.0172
	(0.1278)	(0.1234)
Unknown degree	-0.1441	-0.3846***
	(0.1080)	(0.0832)
Black	-0.3099***	0.1718**
	(0.0818)	(0.0759)
Other races	-0.0846	0.2368***
	(0.0813)	(0.0720)
Female	0.1069	-0.1960***
	(0.0758)	(0.0608)
ROTC Scholarship	0.0564	-0.4473***
	(0.0754)	(0.0669)
USNA	0.1937**	-0.5623***
	(0.0794)	(0.0682)
Other sources	0.2871***	0.1578*
	(0.1003)	(0.0932)
Married	-	0.6047***
	-	(0.0663)
No dependent(s)	-0.2208***	0.1357*
	(0.0722)	(0.0703)
1997 Entrants	-0.0877	-0.1192
	(0.0848)	(0.0757)
1998 Entrants	-0.0025	-0.2581***
	(0.0855)	(0.0741)
1999 Entrants	0.0699	-0.2262***
	(0.0848)	(0.0739)
2000 Entrants	0.1116	-0.4211***
	(0.0899)	(0.0745)
Constant	0.8245***	-0.0743
	(0.0942)	(0.1040)
Rho	-0.8988	
	(0.0483)	
Observations	**3,668**	**3,668**
Overall Sample Rates (%)	**57.95**	**50.44**
Standard errors in parentheses		
***** p<0.01, ** p<0.05, * p<0.1**		

Table 11. Heckman Two-Stage Probit Estimations with Sample Selection (Full Sample).

b. Sample Excluding Those with "Unknown Education" from the Full Sample

We built the following Heckman two-stage probit model with sample selection (excluding officers with unknown education category):

(3b) $$(PROMOTE) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(MASTdeg)_i + \beta_3(DOCTdeg)_i + \beta_4(FPROdeg)_i + \beta_5(OTHERdeg)_i + \beta_6(BLACK)_i + \beta_7(OTHERrace)_i + \beta_8(FEMALE)_i + \beta_9(ROTCsch)_i + \beta_{10}(USNA)_i + \beta_{11}(OTHERsource)_i + \beta_{12}(NOdep)_i + \beta_{13}(ENTRY1997)_i + \beta_{14}(ENTRY1998)_i + \beta_{15}(ENTRY1999)_i + \beta_{16}(ENTRY2000)_i + u_i$$

$$(STAY) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(MASTdeg)_i + \beta_3(DOCTdeg)_i + \beta_4(FPROdeg)_i + \beta_5(OTHERdeg)_i + \beta_6(BLACK)_i + \beta_7(OTHERrace)_i + \beta_8(FEMALE)_i + \beta_9(ROTCsch)_i + \beta_{10}(USNA)_i + \beta_{11}(OTHERsource)_i + \beta_{12}(MARRIED)_i + \beta_{13}(NOdep)_i + \beta_{14}(ENTRY1997)_i + \beta_{15}(ENTRY1998)_i + \beta_{16}(ENTRY1999)_i + \beta_{17}(ENTRY2000)_i + u_i$$

The Heckman two-stage probit model data set includes 3,310 officers, of whom 1,582 are censored and 1,728 are uncensored. The Wald test indicates that the correlation coefficient between error terms is highly significant (Prob>chi square = 0.00), and implies that we can reject the null hypothesis (H_0: there is no sample selection bias), and conclude that there is selection bias. Rho (rho = -0.8775) shows that the error terms in the two models are negatively correlated (see Appendix F for the full results).

Table 12 presents the results for promotion analysis for the sample that omit those with unknown education from the sample. There are no notable differences between the Heckman two-stage probit models. The coefficients of the variables are similar in size and their significance levels are the same for both models.

Estimates show that the most significant changes in the coefficients are observed for officers from other sources with 4.7 percentage points and officers in the 2000 cohort with 5.5 percentage points difference. There are no notable differences for other variables.

HECKMAN PROBIT MODEL WITH SAMPLE SELECTION		
VARIABLES	**MARGINAL EFFECTS PROMOTE**	**MARGINAL EFFECTS STAY**
Officers with prior service	-0.2035***	0.3667***
	(0.0669)	(0.0590)
Master's degree	0.3899***	1.7151***
	(0.0926)	(0.1155)
Doctorate degree	-0.4426**	-0.5365***
	(0.1806)	(0.1397)
First Professional degree	-0.9443***	0.5604
	(0.3626)	(0.3570)
Other degree	-0.4276***	0.0554
	(0.1295)	(0.1242)
Black	-0.2850***	0.1702**
	(0.0863)	(0.0798)
Other races	-0.1012	0.2751***
	(0.0860)	(0.0771)
Female	0.1060	-0.2060***
	(0.0809)	(0.0644)
ROTC Scholarship	0.0665	-0.3849***
	(0.0785)	(0.0715)
USNA	0.2045**	-0.5112***
	(0.0828)	(0.0719)
Other sources	0.3338***	0.2465**
	(0.1085)	(0.1031)
Married	-	0.6219***
	-	(0.0697)
No dependent(s)	-0.2357***	0.1408*
	(0.0750)	(0.0744)
1997 Entrants	-0.1046	-0.1089
	(0.0865)	(0.0767)
1998 Entrants	-0.0051	-0.2379***
	(0.0876)	(0.0755)
1999 Entrants	0.0786	-0.2033***
	(0.0878)	(0.0765)
2000 Entrants	0.0566	-0.4881***
	(0.0972)	(0.0779)
Constant	0.8250***	-0.1258
	(0.0975)	(0.1086)
Rho	-0.8775	
	(0.0535)	
Observations	**3,310**	**3,310**
Overall Sample Rates (%)	**59.26**	**52.21**
Standard errors in parentheses		
***** p<0.01, ** p<0.05, * p<0.1**		

Table 12. Heckman Two-Stage Probit Estimations with Sample Selection (Excludes Officers with "Unknown Education" Category).

4. Probit Model of Graduate Education Decision

The U.S. Navy provides graduate education programs for its officers, such as Naval Postgraduate School programs, and medical and legal education programs. These programs are funded by the U.S. Navy. In the Navy personnel system, "…officers are selected for graduate education after serving 6 or more years" (Bowman and Mehay, 1999, p. 461).

"Which officers choose to have or are chosen by the Navy for advanced education programs?" We try to answer this question by using the demographic variables and accession sources as predictors of who receives graduate education. We created a simple probit model for this and use the full sample. We estimate the following simple probit model:

$$(4) \quad (ADV\_EDUC) = \beta_0 + \beta_1(BLACK)_i + \beta_2(OTHERrace)_i + \beta_3(FEMALE)_i + \beta_4(MARRIED)_i + \beta_5(NOdep)_i + \beta_6(ROTCsch)_i + \beta_7(USNA)_i + \beta_8(OTHERsource)_i + u_i$$

The dependent variable, advanced education, includes Master's degree, First Professional degree, and Doctorate degree holders. The reference groups for the explanatory variables are officers, who are whites, males, singles, with one or more dependents, and OCS graduates. Table 13 shows the results of model (4) (for the full probit results see Appendix G).

The coefficients of all demographic variables are statistically significant except for blacks, other races, and officers with no dependents. Female officers are less likely to choose or to be selected for advanced education than males (2.6 percentage points lower; significant at the 10% level). Married officers have a probability to choose or to be selected for advanced education that is 9.2 percentage points higher than single officers (significant at the 1% level).

ROTC scholarship program graduates and USNA graduates are less likely to be selected for advanced education. Officers from other sources also are less likely to choose or be selected for advanced education than OCS graduates (by 5.4 percentage points; significant at 1% level).

In conclusion, we can say that married officers are more likely to receive an advanced education than single officers. Thus, we expect higher retention rates for married officers due to the obligatory service period imposed by the Navy as a payoff for the advanced education period. OCS graduates are more likely to choose or to be selected for advanced education than all other accession sources, which also should generate higher retention rates for this group.

DEMOGRAPHICS AND ACCESSION SOURCES EFFECTS ON ADVANCED EDUCATION		
VARIABLES	COEFFICIENTS ADVANCED EDUCATION	MARGINAL EFFECTS ADVANCED EDUCATION
Black	0.0836	0.0178
	(0.0841)	(0.0186)
Other Races	-0.0928	-0.0183
	(0.0910)	(0.0171)
Female	-0.1352*	-0.0264*
	(0.0795)	(0.0147)
Married	0.4542***	0.0924***
	(0.0892)	(0.0179)
No Dependents	-0.1012	-0.0206
	(0.0937)	(0.0190)
ROTC Scholarship	-0.6312***	-0.1146***
	(0.0684)	(0.0110)
USNA	-0.5068***	-0.0929***
	(0.0694)	(0.0114)
Other Sources	-0.3091***	-0.0543***
	(0.0977)	(0.0145)
Constant	-0.9314***	
	(0.0954)	
Observations	**3,668**	**3,668**
Likelihood Ratio Chi Square	**254.02**	
Sample Mean for Advanced Education	**0.1445**	
Standard errors in parentheses		
***** p<0.01, ** p<0.05, * p<0.1**		

Table 13. Probit Model Estimations for Demographics and Accession Sources.

5. Probit Model of Master's Degree Holders (Including Stayers Only)

In the previous multivariate models, we included Doctorate degree, First Professional degree, and Master's degree holders into the "advanced education" group, and interpreted the estimation results for the effect of advanced education on the retention and the promotion of Navy SWOs. In model (5), we include only

Master's degree holders in the advanced education group. The reason for this change is that the advanced education fully funded by the Navy consists of mostly Master's degrees. Thus, similar to model 4, we created this model to analyze the effects of demographic variables and accession sources on those who receive a Master's degree. This analysis uses the sample of stayers only. We estimate the following probit model.

(5) $$(MASTdeg) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(BLACK)_i + \beta_3(OTHERrace)_i + \beta_4(FEMALE)_i + \beta_5(ROTCsch)_i + \beta_6(USNA)_i + \beta_7(OTHERsource)_i + \beta_8(MARRIED)_i + \beta_9(NOdep)_i + \beta_{10}(ENTRY1997)_i + \beta_{11}(ENTRY1998)_i + \beta_{12}(ENTRY1999)_i + \beta_{13}(ENTRY2000)_i + u_i$$

The reference groups include those who are non-prior service officers, whites, males, singles, with one or more dependents, OCS graduates, and 1996 entrants. Table 14 shows the results of model (5) (for the full probit results see Appendix H). The p-value of the model is zero; thus, the model is highly significant and at least one of the independent variables explains the dependent variable for Master's degree. The pseudo R square shows that the independent variables explain 8.8% of the variation in Master's degree.

Officers with prior service have a probability to choose or to be selected for Master's degree education that is 5.4 percentage points lower than non-prior service officers (significant at the 5% level). Black and other officers have a probability of receiving a Master's degree education that are 2.8 percentage points and 3.2 percentage points lower than white officers, respectively. Females are also less likely to choose or to be selected for Master's degree education than males. Married officers have a probability of receiving Master's degree education that is 10 percentage points higher than single officers (significant at 1% level). Officers with no dependents are less likely to choose or to be selected for Master's degree education (5.1 percentage points lower).

ROTC scholarship program graduates and USNA have a probability of receiving a Master's degree education that is lower than OCS graduates (significant at the 5% level). In short, the results indicate that OCS graduates are more likely to choose or to be selected for Master's degree education than all other accession

sources. Compared to 1996 entrants, 1997, 1998, 1999, and 2000 entrants are more likely to choose or to be selected for Master's degree education.

SIMPLE PROBIT MODEL OF MASTER'S DEGREE		
	COEFFICIENTS	**MARGINAL EFFECTS**
VARIABLES	**MASTER'S DEGREE**	**MASTER'S DEGREE**
Officers with prior service	-0.1965**	-0.0542**
	(0.0817)	(0.0226)
Black	-0.1069	-0.0283
	(0.1095)	(0.0279)
Other races	-0.1245	-0.0327
	(0.1133)	(0.0285)
Female	-0.1231	-0.0324
	(0.1127)	(0.0284)
ROTC Scholarship	-0.1903**	-0.0502**
	(0.0940)	(0.0238)
USNA	-0.1126	-0.0301
	(0.1026)	(0.0267)
Other sources	-0.4214***	-0.0990***
	(0.1274)	(0.0249)
Married	0.3884***	0.1004***
	(0.1256)	(0.0304)
No dependent(s)	-0.1925	-0.0512
	(0.1322)	(0.0341)
1997 Entrants	0.2247*	0.0652*
	(0.1192)	(0.0363)
1998 Entrants	0.2456**	0.0716*
	(0.1192)	(0.0367)
1999 Entrants	0.1601	0.0457
	(0.1197)	(0.0355)
2000 Entrants	0.8870***	0.2863***
	(0.1109)	(0.0391)
Constant	-1.1096***	
	(0.1729)	
Overall Sample Master's Degree Rate (%)	**21.41**	
Observations	**1,850**	**1,850**
Likelihood Ratio Chi Square	**168.69**	
Standard errors in parentheses		
***** p<0.01, ** p<0.05, * p<0.1**		

Table 14. Probit Model Estimations of Master's Degree

6. Bivariate Probit Model for Master's Degrees and Promotion

Using the stayers sample as the data set for the multivariate regression models may cause selection bias. We don't know what the promotion probability would be

for the officers to voluntarily select the Navy's graduate program or be selected by the Navy to participate in Master's degree programs, if the separated officers were still in the service. Thus, we should correct for the selection bias issue to reach consistent estimates of the effect of MA degrees on promotion. Therefore, we estimate a bivariate probit model to correct for selection bias, where the "marital status" variable is used as an IV as in the previous models. The reason to choose "marital status" as an IV is that we believe that marital status affects the decision to undertake a Master's degree, but possibly is not correlated with promotion. The bivariate probit model is specified as follows.

(6a) $$(PROMOTE) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(BLACK)_i + \beta_3(OTHERrace)_i + \beta_4(FEMALE)_i + \beta_5(ROTCsch)_i + \beta_6(USNA)_i + \beta_7(OTHERsource)_i + \beta_8(NOdep)_i + \beta_9(ENTRY1997)_i + \beta_{10}(ENTRY1998)_i + \beta_{11}(ENTRY1999)_i + \beta_{12}(ENTRY2000)_i + u_i$$

(6b) $$(MASTdeg) = \beta_0 + \beta_1(PRIORservice)_i + \beta_2(BLACK)_i + \beta_3(OTHERrace)_i + \beta_4(FEMALE)_i + \beta_5(ROTCsch)_i + \beta_6(USNA)_i + \beta_7(OTHERsource)_i + \beta_8(MARRIED)_i + \beta_9(NOdep)_i + \beta_{10}(ENTRY1997)_i + \beta_{11}(ENTRY1998)_i + \beta_{12}(ENTRY1999)_i + \beta_{13}(ENTRY2000)_i + u_i$$

The bivariate probit model uses the sample of stayers (1,850 officers). Table 16 shows the estimation results for the bivariate probit model (see Appendix J for the full results).

The results show that officers with Master's degree are more than twice as likely to be promoted as officers with other degrees. However, It appears that this coefficient is implausibly high and biased upward, which is the classic result of a weak IV. One potential reason for this inflated result is due to the use of a weak IV in the model. Unfortunately, there are no other variables in the data set that can be used as an IV.

Officers with prior service have a promotion probability that is 2.8 percentage points higher than non-prior service officers. Black officers have a promotion probability that is 23.8 percentage points lower than white officers (significant at 5% level). The promotion probability for other race officers is higher than white officers (by 6.6 percentage points). Female officers are promoted at higher rates than male officers (2.9 percentage points higher). Officers with no dependents have a promotion

probability that is 37.3 percentage points lower than officers with one or more dependents (significant at the 1% level).

Compared to OCS graduates, ROTC scholarship program graduates have a promotion probability that is 0.05 percentage points lower; and USNA graduates have a promotion probability that is 9.4 percentage points higher than OCS graduates. Officers from other sources are promoted at higher rates than OCS graduates (53 percentage points higher; significant at 1% level).

Among all cohorts, the 1997 entrants are less likely to be promoted than 1996 entrants (by 26.1 percentage points; significant at 1% level). The 1998 entrants have a promotion probability that is 23.4 percentage points lower than 1996 entrants (significant at 5% level), while 1999 entrants have a promotion probability that is 13.3 percentage points lower than 1996 entrants, and 2000 entrants are promoted at lower rates than 1996 entrants (51.9 percentage points lower).

BIVARIATE PROBIT MODEL		
VARIABLES	MARGINAL EFFECTS PROMOTE	MARGINAL EFFECTS MASTER'S DEGREE
Master's Degree Holders	2.1035***	-
	(0.1270)	-
Officers with prior service	0.0279	-0.2096***
	(0.0692)	(0.0796)
Black	-0.2384**	-0.0974
	(0.0929)	(0.1074)
Other races	0.0663	-0.1174
	(0.0918)	(0.1113)
Female	0.0293	-0.1267
	(0.0901)	(0.1074)
ROTC Scholarship	-0.0005	-0.1709*
	(0.0805)	(0.0923)
USNA	0.0938	-0.1103
	(0.0870)	(0.0995)
Other sources	0.5301***	-0.4311***
	(0.1040)	(0.1310)
No dependents	-0.3725***	-0.0337
	(0.0834)	(0.1224)
1997 Entrants	-0.2613***	0.2148*
	(0.0945)	(0.1183)
1998 Entrants	-0.2342**	0.2679**
	(0.0952)	(0.1179)
1999 Entrants	-0.1330	0.1792
	(0.0950)	(0.1181)
2000 Entrants	-0.5194***	0.8884***
	(0.1030)	(0.1098)
Married	-	0.5392***
	-	(0.1112)
Constant	0.0378	-1.2573***
	(0.1143)	(0.1624)
Rho	-0.7806	
	(0.1261)	
Observations	**1,850**	**1,850**
Standard errors in parentheses		
***** p<0.01, ** p<0.05, * p<0.1**		

Table 15. Bivariate Probit Model Estimation

C. CHAPTER SUMMARY

This chapter discussed the results of estimation of the retention and promotion models and discussed the interpretation of the results of these models. We created simple probit models and Heckman two-stage probit models with sample selection.

The retention analysis results show that except for Doctorate degree holders, Master's degree holders and First Professional degree holders are more likely to stay in service compared to Baccalaureate degree holders. The promotion analysis indicates that only Master's degree holders have a higher promotion probability than Baccalaureate degree holders. Surprisingly, Doctorate degree and First Professional degree holders have a lower promotion probability than Bachelors degree holders.

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V. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

This thesis examines the effect of advanced education on the retention and the promotion of SWOs in the U.S. Navy. Multivariate probit regression and Heckman two-stage probit model with sample selection techniques are used in the analyses. There are nine different estimation models created to answer following questions:

1) What is the effect of any advanced education on the retention of SWOs in the U.S. Navy?

2) What is the effect of any advanced education on the promotion of SWOs in the U.S. Navy?

3) What factors, other than education level, affect the retention decisions of SWOs?

4) What factors, other than education level, affect the promotion of SWOs?

5) What officers choose to participate in advanced education program or are selected for these programs by the Navy?

6) What is the effect of funded Master's degrees on promotion?

In the full sample, retention analysis results show that Master's degree holders and First Professional degree holders are more likely to stay in service compared to Baccalaureate degree holders (48.5 percentage points and 20.7 percentage points, respectively). Doctorate degree holders have a retention probability that is 21.9 percentage points lower than Bachelor's degree holders.

In the sample excluding officers with unknown education, retention analysis results show that Master's degree holders and First Professional degree holders are more likely to stay in service compared to Baccalaureate degree holders by 47.8 percentage points and 21.9 percentage points, respectively. Doctorate degree holders have a retention probability that is 21 percentage points lower than Bachelor's degree holders. Results for officers with other degrees are not statistically significant.

Table 17 presents the hypothesized and actual effects of the explanatory variables in the retention and promotion outcomes. As we have hypothesized, the promotion analysis results show that only Master's degree holders have a higher promotion probability than Baccalaureate degree holders. Surprisingly, Doctorate degree and First Professional degree holders have lower promotion rates.

The promotion analysis shows that Master's degree holders have a higher promotion rate than Baccalaureate degree holders. Surprisingly, Doctorate degree and First Professional degree holders have lower promotion rates than Bachelor's degree holders.

HYPOTHESIZED AND ACTUAL EFFECTS OF THE VARIABLES

	Officers with Prior Service	Master's Degree Holders	Doctorate Degree Holders	First Professional Degree Holders	Other Degree Holders	Unknown Degree Holders	Black Officers	Officers with Other Races	Female	Other Sources	ROTC Scholarship Program	U.S. Naval Academy	Married Officers	No Dependents
Retention (Hypothesized)	+	+	-	-	+	UNK	+	UNK	-	-	+	+	+	-
Promotion (Hypothesized)	+	+	+	+	-	UNK	UNK	UNK	+	-	+	+	NI	-
Retention (Actual)	+ SIG	+ SIG	- SIG	+ SIG	+ INSIG	- SIG	+ SIG	+ SIG	- SIG	+ SIG	- SIG	- SIG	+ SIG	+ INSIG
Promotion (Actual)	+ INSIG	+ SIG	- SIG	- SIG	- SIG	- SIG	- SIG	+ INSIG	+ INSIG	+ SIG	- SIG	- INSIG	NI	- SIG

NOTES:
1) Reference groups: Baccalaureate degree holders, white officers, males, from OCS, single officers, and having one or more dependents.
2) UNK: Unknown.
3) SIG: Significant
4) INSIG: Insignificant
5) NI: Not Included.

Table 16. Hypothesized and Actual Effects of the Variables.

The promotion result for Doctorate degree holders is different than what we hypothesized. Additionally, retention and promotion results for First Professional degree holders and USNA graduates are different from our hypothesis. However, the sample sizes for those degrees were very small, which likely affected the precision and reliability of these estimates.

In addition to these estimations, the Heckman two-stage probit models are estimated. Results from the Heckman two-stage probit model indicate that Master's degree holders are promoted at higher rates than Bachelor's degree holders, whereas Doctorate degree and First Professional degree holders have lower promotion rates.

We also analyzed the effects of demographic variables and accession sources on advanced degrees. The probit estimation shows that:

- Female officers are less likely to choose or to be selected for advanced education (2.4 percentage points lower),
- Married officers are more likely to choose or to be selected for advanced education (9.2 percentage points higher),
- ROTC scholarship program graduates are less likely to choose or to be selected for advanced education (11.5 percentage points lower),
- USNA graduates are less likely to choose or to be selected for advanced education (9.3 percentage points lower),
- Officers from other commissioning sources are less likely to choose or to be selected for advanced education (5.4 percentage points lower).

We also estimated a bivariate probit model to adjust for sample selection bias using from those who select to participate in the Navy's funded graduate education program. Bivariate probit model results indicate that Master's degree holders have a promotion probability that is more than twice that of other degree holders. As explained in Chapter IV, this result is implausibly high compared to previous studies. Bowman and Mehay (1999) also used a bivariate probit model to analyze the effect of graduate education (Master's degree) on the promotion of Navy line and staff officers, and found that Master's degree holders are more likely to be promoted by 4.5 percentage points than non-Master's degree holders. The large effect in this thesis is likely due to the use of a weak IV in the bivariate probit model.

Table 18 shows all the estimation results and marginal effects from all of the models estimated in this thesis.

Table 19 summarizes and compasses the findings from previous studies in graduate education and this study. For the retention analyses, Wielsma (1996) indicated that advanced degree holders were more likely to stay, and Conzen (1999)

found that Master's degree holders were more likely to stay except for years 1993 and 1997. Branigan (2001) indicated that Master's degree holders in the U.S. Marine Corps were more likely to stay. Kahraman (2007) found that Master's degree, Doctorate degree, and Professional degree holders were more likely to stay in service. The results from our study show that Master's degree holders and First Professional degree holders are more likely to stay compared to Bachelor's degree holders, while Doctorate degree holders stay at lower rates. However, the results seem to be biased upward due to the usage of a weak instrumental variable.

For the promotion analyses, Wielsma (1996) found that advanced degree holders were more likely to be promoted. Bowman and Mehay (1999), and Branigan (2001) also found that Master's degree holders are more likely to be promoted. Kahraman (2007) indicates that Master's degree and Doctorate degree holders were more likely to be promoted. The results from this study indicate that Master's degree holders are more likely to be promoted, while First Professional degree and Doctorate degree holders are less likely to be promoted compared to Bachelor's degree holders.

There are several weaknesses in this study:

- We could not observe the promotion zones precisely (especially the in-zone promotions). The data set did not include the necessary variables to distinguish these zones clearly; thus, we assumed that the promotion point to O-4 accounted at the tenth year of service.
- We did not focus on the effect of economic factors on retention. Most retention models examine the effect of economic factors, such as civilian earnings and civilian unemployment, because officers are comparing staying in the military with leaving and getting a civilian job. We didn't have any variables that would proxy conditions in the civilian labor market. For that reason, our model is likely misspecified.
- All of the estimations from the simple probit models may suffer from selection bias. Thus, we ran Heckman two-stage probit model with sample selection to correct for this bias. However, the data set used did not include a variable that would qualify as a strong IV.

We used “marital status” as an IV for the retention model, but the results showed that we could not solve the selection bias problem sufficiently due to the weak instrumental variable.

	ESTIMATION RESULTS OF ALL MODELS IN THE STUDY																	
	Simple Probit Model for Retention (Including Unknown Education Category)		Simple Probit Model for Retention (Excluding Unknown Education Category)		Simple Probit Model for Promotion (Including Unknown Education Category)		Simple Probit Model for Promotion (Excluding Unknown Education Category)		Heckman Two-Stage Probit Model With Sample Selection (Including Unknown Education Category)		Heckman Two-Stage Probit Model With Sample Selection (Excluding Unknown Education Category)		Simple Probit Model for Advanced Education (Including Demographics and Accession Sources Only)		Simple Probit Model for Master's Degree Holders (Including Stayers Only)		Bivariate Probit Model (Including Stayers Only)	
Number of Observations →	**3668**		**3310**		**1850**		**1728**		**3668**		**3310**		**3668**		**1850**		**1850**	
	Percentage Points	Percentage (%)	Percentage Points	Percentage (%)	Percentage Points	Percentage (%)	Percentage Points	Percentage (%)	Percentage Points	Percentage (%)	Percentage Points	Percentage (%)	Percentage Points	Percentage (%)	Percentage Points	Percentage (%)	Percentage Points	Percentage (%)
Officers with Prior Service	16.0	40.8	14.8	35.7	0.7	1.2	-1.6	-2.7	-18.2	-32.2	-20.4	-34.5	NA	NA	-5.4	-11.6	2.8	6.1
Master's degree	48.5	108.7	47.8	107.1	31.6	59.4	32.4	60.9	36.1	67.9	39.0	73.3	NA	NA	NA	NA	210.4	308.1
Doctorate degree	-21.9	-49.1	-20.8	-46.6	-34.3	-64.4	-33.6	-63.1	-43.0	-80.8	-44.3	-83.2	NA	NA	NA	NA	NA	NA
First Professional degree	20.7	46.4	22.0	49.3	-35.6	-66.9	-34.2	-64.3	-95.2	-178.9	-94.4	-177.4	NA	NA	NA	NA	NA	NA
Other degree	1.7	3.8	2.9	6.5	-20.6	-38.7	-19.3	-36.3	-43.7	-82.1	-42.8	-80.4	NA	NA	NA	NA	NA	NA
Unknown degree	-14.9	-33.4	NA	NA	-17.0	-31.9	NA	NA	-14.4	-27.1	NA	NA	NA	NA	NA	NA	NA	NA
Black	6.1	12.6	5.8	11.5	-13.5	-22.5	-12.2	-19.9	-31.0	-51.8	-28.5	-46.5	1.8	2.3	-2.8	-3.7	-23.8	-30.4
Other Races	9.0	18.5	10.2	20.3	0.4	0.7	-0.1	-0.2	-8.5	-14.2	-10.1	-16.5	-1.8	-2.3	-3.3	-4.4	6.6	8.4
Female	-8.1	-15.1	-8.5	-15.3	0.4	0.7	0.4	0.7	10.7	18.0	10.6	17.5	-2.6	-3.2	-3.2	-3.7	2.9	3.2
ROTC Scholarship Program	-17.7	-26.1	-15.5	-21.6	-7.3	-12.2	-5.4	-8.8	5.6	9.4	6.7	10.9	-11.5	-40.6	-5.0	-13.1	-0.1	-0.1
USNA	-21.3	-31.4	-19.5	-27.1	-1.4	-2.3	-0.1	-0.2	19.4	32.5	20.5	33.4	-9.3	-32.8	-3.0	-7.9	9.4	23.9
Other Sources	7.3	10.8	10.2	14.2	17.9	30.0	19.7	32.1	28.7	48.1	33.4	54.4	-5.4	-19.0	-9.9	-26.0	53.0	135.0
Married	22.2	63.2	21.9	59.8	NA	NA	NA	NA	NA	NA	NA	NA	9.2	19.2	10.0	30.0	NA	NA
No dependents	3.7	6.0	3.3	5.2	-23.8	-35.8	-23.3	-34.5	-22.1	-33.3	-23.6	-35.0	-2.1	-3.8	-5.1	-7.5	-37.3	-48.2
1997 Cohort	-5.1	-27.6	-4.5	-23.1	-8.2	-41.9	-8.4	-41.4	-8.8	-44.9	-10.5	-51.7	NA	NA	6.5	35.2	-26.1	-133.2
1998 Cohort	-9.9	-53.5	-9.1	-46.8	-6.9	-35.2	-6.4	-31.5	-0.3	-1.5	-0.5	-2.5	NA	NA	7.2	38.9	-23.4	-119.4
1999 Cohort	-8.3	-44.9	-7.4	-38.1	-2.1	-10.7	-0.6	-3.0	7.0	35.7	7.9	38.9	NA	NA	4.6	24.9	-13.3	-67.9
2000 Cohort	-16.7	-90.3	-19.2	-98.8	-5.6	-28.6	-9.6	-47.3	11.2	57.2	5.7	28.1	NA	NA	28.6	154.7	-51.9	-264.9

Table 17. Estimation Results (Marginal Effects) of all the Models.

STUDY BY	RESEARCH GROUP	RESEARCH AREA	METHODOLOGY	DATA FROM	SAMPLE SIZE	FINDINGS	
						Retention	Promotion
Wielsma (1996)	U.S. Marine Corps (USMC)	Analyzed the effects of various factors, including graduate education, on retention to the O-4 promotion board, selection for promotion to O-4, and performance ratings.	Non-parametric analysis, OLS, Simple Probit Model	The Defense Manpower Data Center (DMDC) with the USMC's Automated Fitness Report System (AFRS), the USMC Headquarters Master File (HMF) and the USMC's Official Military Personnel File (OMPF)	1,087	Simple Probit Model: Advanced degree holders are more likely to stay by **106.56** percentage points. Controlling for Bias with one IV: Advanced degree holders are more likely to stay by **86.32** percentage points.	Simple Probit Model: Advanced degree holders are more likely to be promoted by **47.61** percentage points. Controlling for Bias with one IV: Advanced degree holders are more likely to be promoted by **47.76** percentage points. Controlling for Bias (exchanged IV): Advanced degree holders are more likely to be promoted by **39.09** percentage points. Controlling for Bias with two IVs: Advanced degree holders are more likely to be promoted by **38.73** percentage points.
Bowman and Mehay (1999)	Navy Officers	Examined the relationship between graduate education and on-the-job performance.	Simple Probit Model, Bivariate Probit Model	The Navy's Promotion History File between the years 1985 and 1990, and officer fitness reports.	6,583	NA	Simple Probit Model: Line and Staff officers with Master's degrees are more likely to be promoted by **9.8** and **14.5** percentage points, respectively. Controlling for bias with ability/performance: Line and Staff officers with Master's degrees are more likely to be promoted by **6.5** and **8.9** percentage points, respectively. Bivariate Probit Model: Line and Staff officers with Master's degrees are more likely to be promoted by **5.6** and **5.1** percentage points, respectively.
Conzen (1999)	Navy Officers	Investigated the effects of fully funded graduate education on the retention.	Logit Model	Officer Master Record Files (OMRF) provided by DMDC	33,000 to 40,000	Year 1992: Master's degree holders are more likely to stay by **46.5%-48.8%**. Year 1993: Master's degree holders are less likely to stay by **42.3%-47.5%**. Year 1995: Master's degree holders are more likely to stay by **45%** and **47%** less likely to stay for non-funded MAs. Year 1996: Master's degree holders are more likely to stay by **46%-48%**, and **47.9%** less likely to stay for non-funded MAs. Year 1997: Master's degree holders are less likely to stay by **47%-49%**.	NA

Table 18. Comparison of Previous Studies with this Thesis.

STUDY BY	RESEARCH GROUP	RESEARCH AREA	METHODOLOGY	DATA FROM	SAMPLE SIZE	FINDINGS	
						Retention	Promotion
Branigan (2001)	U.S. Marine Corps (USMC)	Analyzed the factors that affected retention and promotion.	Non-parametric analysis, Simple Probit Model, Bivariate Probit Model, Heckman Two-Stage Probit Model with Sample Selection	Manpower Plans Division at Headquarters Marine Corps, Center for Naval Analyses (CNA) and DMDC, Registrar at NPS	6,507 and 1,627 for promotion analysis	Simple Probit Model: Master's degree holders are more likely to stay by **12** percentage points.	Simple Probit Model: Master's degree holders are more likely to be promoted by **21.5** percentage points. Controlling for bias with performance: Master's degree holders are more likely to be promoted by **15.04** percentage points. Bivariate Probit Model: Master's degree holders are more likely to survive and be promoted by **13.5** percentage points. Heckman Procedure: Master's degree holders are more likely to be promoted by **22.95** percentage points.
Kahraman (2007)	Army Officers	Examined the effects of advanced education on retention and promotion.	Survival Analysis	Active Duty Military Master File provided by the DMDC	45,228 for retention analysis and 12,092 for promotion analysis	Master's degree holders are more likely to stay by **29.13%**. Doctorate degree holders are more likely to stay by **23.94%**. Professional degree holders are more likely to stay by **8.21%**.	Master's and Doctorate degree holders are more likely to be promoted by **115.3%**. Professional degree does not have significant effect on promotion.
Abunaz and Torun (2012)	Navy Surface Warfare Officers	Examined the effects of advanced education on retention and promotion.	Simple Probit Model, Heckman Two-Stage Probit Model with Sample Selection, Bivariate Probit Model	The online Navy Econometric Modeling System (NEMS)	3,668 for retention analysis and 1,850 for promotion analysis	Simple Probit Model: Master's degree holders are more likely to stay by **48.5** percentage points. Doctorate degree holders are less likely to stay by **21.9** percentage points. First Professional degree holders are more likely to stay by **20.7** percentage points.	Simple Probit Model: Master's degree holders are more likely to be promoted by **31.6** percentage points. Doctorate degree holders are less likely to be promoted by **34.3** percentage points. First Professional degree holders are less likely to be promoted by **35.6** percentage points. Heckman Procedure: Master's degree holders are more likely to be promoted by **36.1** percentage points. Doctorate degree holders are less likely to be promoted by **43** percentage points. First Professional degree holders are less likely to be promoted by **95.2** percentage points. Bivariate Probit Model: Master's degree holders are more likely to survive and be promoted by **210.4** percentage points.

Table 18 (continued). Comparison of Previous Studies with this Thesis.

B. RECOMMENDATIONS

This study covers only SWOs, thus these results do not apply to other Navy officer communities. Future research should be conducted on data including officers from other communities in the Navy.

The lack of some variables such as fitness reports, AFQT scores, college grades and other aptitude measures may result in model misspecification. Moreover, future research would benefit from a research design that includes an exogenous source of variation in receiving an advanced degree.

For the retention analysis, there was a significant difference before and after 2003. We believe that this difference is because of the Iraq War (2003), and the effect of the war on the retention and promotion should be studied in further analysis.

In order to obtain more accurate results for promotion analysis, promotion to O-5 also should be included in an analysis with a broader data set, because more rigorous selection for promotion begins at that promotion point.

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APPENDIX A. STATA OUTPUTS FOR RETENTION ANALYSIS WITH "UNKNOWN EDUCATION" DEGREE

```
Probit regression                                 Number of obs   =       3668
                                                  LR chi2(18)     =    1034.50
                                                  Prob > chi2     =     0.0000
Log likelihood = -2025.0766                       Pseudo R2       =     0.2035
```

STAY	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PRIORservice	.4054117	.0560961	7.23	0.000	.2954654	.515358
MASTdeg	1.672566	.115305	14.51	0.000	1.446572	1.898559
DOCTdeg	-.5664661	.1400481	-4.04	0.000	-.8409554	-.2919769
FPROdeg	.5599317	.3638544	1.54	0.124	-.1532098	1.273073
OTHERdeg	.0437228	.1253201	0.35	0.727	-.2018999	.2893456
UNKNdeg	-.3763508	.0833032	-4.52	0.000	-.5396221	-.2130795
BLACK	.1540305	.0775137	1.99	0.047	.0021064	.3059546
OTHERrace	.2298319	.0734649	3.13	0.002	.0858433	.3738205
FEMALE	-.2029207	.0614152	-3.30	0.001	-.3232923	-.0825491
ROTCsch	-.4460698	.0676047	-6.60	0.000	-.5785725	-.3135671
USNA	-.5399538	.0688769	-7.84	0.000	-.67495	-.4049576
OTHERsource	.1852873	.0950038	1.95	0.051	-.0009168	.3714914
MARRIED	.5641072	.0723165	7.80	0.000	.4223694	.7058449
NOdep	.0938499	.0749502	1.25	0.211	-.0530497	.2407496
ENTRY1997	-.1274803	.0771919	-1.65	0.099	-.2787737	.0238131
ENTRY1998	-.2483198	.0756318	-3.28	0.001	-.3965554	-.1000842
ENTRY1999	-.2095289	.0753085	-2.78	0.005	-.3571308	-.0619269
ENTRY2000	-.4225962	.0759126	-5.57	0.000	-.5713822	-.2738101
_cons	-.0458477	.1083651	-0.42	0.672	-.2582393	.166544

```
Probit regression, reporting marginal effects     Number of obs =   3668
                                                  LR chi2(18)   =1034.50
                                                  Prob > chi2   = 0.0000
Log likelihood = -2025.0766                       Pseudo R2     = 0.2035
```

STAY	dF/dx	Std. Err.	z	P>|z|	x-bar	[	95% C.I.	]
PRIORs~e*	.1594803	.0216584	7.23	0.000	.399945	.117031	.20193	
MASTdeg*	.4845243	.0163035	14.51	0.000	.113413	.45257	.516479	
DOCTdeg*	-.2192095	.0501838	-4.04	0.000	.026718	-.317568	-.120851	
FPROdeg*	.2071591	.1185564	1.54	0.124	.004362	-.025207	.439525	
OTHERdeg*	.0173534	.0496305	0.35	0.727	.037077	-.07992	.114627	
UNKNdeg*	-.1488889	.0322204	-4.52	0.000	.097601	-.21204	-.085738	
BLACK*	.0607806	.0302662	1.99	0.047	.104962	.00146	.120101	
OTHERr~e*	.0901759	.028263	3.13	0.002	.108506	.034782	.14557	
FEMALE*	-.0808047	.0243979	-3.30	0.001	.182661	-.128624	-.032986	
ROTCsch*	-.1764906	.0263142	-6.60	0.000	.327426	-.228066	-.124916	
USNA*	-.2127623	.0264256	-7.84	0.000	.306707	-.264555	-.160969	
OTHERs~e*	.0729029	.0368184	1.95	0.051	.082334	.00074	.145066	
MARRIED*	.2215878	.0276937	7.80	0.000	.52072	.167309	.275866	
NOdep*	.0372903	.0297476	1.25	0.211	.444656	-.021014	.095594	
ENT~1997*	-.0507833	.0307586	-1.65	0.099	.179117	-.111069	.009502	
ENT~1998*	-.09881	.0299526	-3.28	0.001	.197655	-.157516	-.040104	
ENT~1999*	-.0834187	.0299104	-2.78	0.005	.217285	-.142042	-.024795	
ENT~2000*	-.1672832	.029518	-5.57	0.000	.24482	-.225137	-.109429	
obs. P	.5043621							
pred. P	.5320346	(at x-bar)						

```
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| correspond to the test of the underlying coefficient being 0
```

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APPENDIX B. STATA OUTPUTS FOR RETENTION ANALYSIS WITHOUT "UNKNOWN EDUCATION" DEGREE

```
Probit regression                                 Number of obs   =       3310
                                                  LR chi2(17)     =     935.02
                                                  Prob > chi2     =     0.0000
Log likelihood = -1823.5883                       Pseudo R2       =     0.2041
```

STAY	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PRIORservice	.3784413	.0595386	6.36	0.000	.2617477	.4951348
MASTdeg	1.700562	.1157416	14.69	0.000	1.473712	1.927411
DOCTdeg	-.529234	.1410165	-3.75	0.000	-.8056213	-.2528467
FPROdeg	.6152786	.3647285	1.69	0.092	-.0995761	1.330133
OTHERdeg	.0745801	.126138	0.59	0.554	-.1726458	.3218061
BLACK	.1488142	.0814922	1.83	0.068	-.0109076	.3085359
OTHERrace	.264576	.0785871	3.37	0.001	.1105481	.4186039
FEMALE	-.214749	.0648743	-3.31	0.001	-.3419003	-.0875977
ROTCsch	-.3931557	.0724566	-5.43	0.000	-.535168	-.2511434
USNA	-.4954989	.0727524	-6.81	0.000	-.638091	-.3529067
OTHERsource	.2636688	.1050448	2.51	0.012	.0577848	.4695529
MARRIED	.5614261	.0762036	7.37	0.000	.4120697	.7107825
NOdep	.0830845	.0790005	1.05	0.293	-.0717536	.2379225
ENTRY1997	-.1142286	.0781015	-1.46	0.144	-.2673047	.0388475
ENTRY1998	-.228585	.0769901	-2.97	0.003	-.3794828	-.0776871
ENTRY1999	-.1862939	.0777808	-2.40	0.017	-.3387415	-.0338462
ENTRY2000	-.4870488	.0794353	-6.13	0.000	-.6427392	-.3313584
_cons	-.0727203	.113495	-0.64	0.522	-.2951665	.1497259

```
Probit regression, reporting marginal effects     Number of obs =   3310
                                                  LR chi2(17)   = 935.02
                                                  Prob > chi2   = 0.0000
Log likelihood = -1823.5883                       Pseudo R2     = 0.2041
```

STAY	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.	]
PRIORs~e*	.147884	.0228545	6.36	0.000	.410272	.10309	.192678
MASTdeg*	.477857	.0156981	14.69	0.000	.12568	.447089	.508625
DOCTdeg*	-.2074619	.0525514	-3.75	0.000	.029607	-.310461	-.104463
FPROdeg*	.2196869	.1099298	1.69	0.092	.004834	.004228	.435145
OTHERdeg*	.0293047	.0492499	0.59	0.554	.041088	-.067223	.125833
BLACK*	.0581732	.0314345	1.83	0.068	.107251	-.003437	.119784
OTHERr~e*	.1021971	.0294265	3.37	0.001	.10574	.044522	.159872
FEMALE*	-.0852997	.0257964	-3.31	0.001	.179758	-.13586	-.03474
ROTCsch*	-.155433	.0284089	-5.43	0.000	.332628	-.211113	-.099753
USNA*	-.1953966	.0282276	-6.81	0.000	.328097	-.250722	-.140071
OTHERs~e*	.1016827	.039167	2.51	0.012	.079154	.024917	.178449
MARRIED*	.2194422	.0290883	7.37	0.000	.527795	.16243	.276454
NOdep*	.0327955	.0311456	1.05	0.293	.438973	-.028249	.09384
ENT~1997*	-.045301	.0310534	-1.46	0.144	.194562	-.106164	.015562
ENT~1998*	-.0907591	.0305835	-2.97	0.003	.208157	-.150702	-.030817
ENT~1999*	-.0739518	.0309303	-2.40	0.017	.206647	-.134574	-.013329
ENT~2000*	-.1924008	.0307661	-6.13	0.000	.216012	-.252701	-.1321
obs. P	.5220544						
pred. P	.555186	(at x-bar)					

```
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| correspond to the test of the underlying coefficient being 0
```

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APPENDIX C. STATA OUTPUTS FOR PROMOTION ANALYSIS WITH "UNKNOWN EDUCATION" DEGREE

```
Probit regression                                 Number of obs   =       1850
                                                  LR chi2(17)     =     350.00
                                                  Prob > chi2     =     0.0000
Log likelihood = -1083.8595                       Pseudo R2       =     0.1390
```

PROMOTE	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PRIORservice	.0179398	.0747982	0.24	0.810	-.1286619	.1645416
MASTdeg	.9245288	.0912901	10.13	0.000	.7456034	1.103454
DOCTdeg	-.9052351	.214632	-4.22	0.000	-1.325906	-.4845642
FPROdeg	-.9479249	.4337328	-2.19	0.029	-1.798026	-.0978242
OTHERdeg	-.5217613	.1491082	-3.50	0.000	-.814008	-.2295146
UNKNdeg	-.4286952	.1353487	-3.17	0.002	-.6939738	-.1634165
BLACK	-.3422407	.0974672	-3.51	0.000	-.533273	-.1512085
OTHERrace	.0107375	.0978711	0.11	0.913	-.1810864	.2025614
FEMALE	.0096595	.0960024	0.10	0.920	-.1785018	.1978207
ROTCsch	-.186571	.087198	-2.14	0.032	-.3574759	-.0156661
USNA	-.0355558	.0956887	-0.37	0.710	-.2231022	.1519906
OTHERsource	.4962504	.1129462	4.39	0.000	.2748799	.717621
NOdep	-.6100626	.072357	-8.43	0.000	-.7518798	-.4682455
ENTRY1997	-.2086212	.1003199	-2.08	0.038	-.4052447	-.0119977
ENTRY1998	-.1762461	.1016321	-1.73	0.083	-.3754414	.0229492
ENTRY1999	-.0531731	.1016301	-0.52	0.601	-.2523644	.1460182
ENTRY2000	-.1427524	.1059125	-1.35	0.178	-.350337	.0648322
_cons	.4765901	.111922	4.26	0.000	.2572271	.6959531

```
Probit regression, reporting marginal effects     Number of obs =   1850
                                                  LR chi2(17)   = 350.00
                                                  Prob > chi2   = 0.0000
Log likelihood = -1083.8595                       Pseudo R2     = 0.1390
```

PROMOTE	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
PRIORs~e*	.0069509	.0289848	0.24	0.810	.532973	-.049858	.06376
MASTdeg*	.3160117	.0254162	10.13	0.000	.214054	.266197	.365827
DOCTdeg*	-.3434406	.070041	-4.22	0.000	.024324	-.480718	-.206163
FPROdeg*	-.3560126	.1357078	-2.19	0.029	.007027	-.621995	-.09003
OTHERdeg*	-.2058092	.0576001	-3.50	0.000	.050811	-.318703	-.092915
UNKNdeg*	-.1694606	.0532425	-3.17	0.002	.065946	-.273814	-.065107
BLACK*	-.1350017	.0386321	-3.51	0.000	.124865	-.210719	-.059284
OTHERr~e*	.0041556	.0378392	0.11	0.913	.117838	-.070008	.078319
FEMALE*	.0037389	.0371267	0.10	0.920	.13027	-.069028	.076506
ROTCsch*	-.0728736	.0342564	-2.14	0.032	.267027	-.140015	-.005732
USNA*	-.0138043	.0372278	-0.37	0.710	.239459	-.086769	.059161
OTHERs~e*	.1786485	.0366685	4.39	0.000	.112432	.10678	.250517
NOdep*	-.2375481	.0277214	-8.43	0.000	.324324	-.291881	-.183215
ENT~1997*	-.0817652	.0396255	-2.08	0.038	.195676	-.15943	-.004101
ENT~1998*	-.0689865	.0400861	-1.73	0.083	.195676	-.147554	.009581
ENT~1999*	-.0206741	.0396489	-0.52	0.601	.201622	-.098385	.057036
ENT~2000*	-.055748	.0416281	-1.35	0.178	.222162	-.137338	.025842
obs. P	.5794595						
pred. P	.5957017	(at x-bar)					

```
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| correspond to the test of the underlying coefficient being 0
```

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APPENDIX D. STATA OUTPUTS FOR PROMOTION ANALYSIS WITHOUT "UNKNOWN EDUCATION" DEGREE

```
Probit regression                                 Number of obs   =       1728
                                                  LR chi2(16)     =     322.88
                                                  Prob > chi2     =     0.0000
Log likelihood = -1006.5155                       Pseudo R2       =     0.1382
```

PROMOTE	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PRIORservice	-.0407547	.0781774	-0.52	0.602	-.1939796	.1124703
MASTdeg	.9664955	.0923274	10.47	0.000	.7855371	1.147454
DOCTdeg	-.8751913	.2154748	-4.06	0.000	-1.297514	-.4528685
FPROdeg	-.8974977	.4375611	-2.05	0.040	-1.755102	-.0398937
OTHERdeg	-.4881501	.1496957	-3.26	0.001	-.7815483	-.1947519
BLACK	-.3105877	.1013708	-3.06	0.002	-.5092708	-.1119046
OTHERrace	-.0036721	.1015913	-0.04	0.971	-.2027874	.1954432
FEMALE	.0106153	.1000506	0.11	0.916	-.1854803	.2067109
ROTCsch	-.1399706	.0894101	-1.57	0.117	-.3152112	.0352701
USNA	-.0031519	.0979801	-0.03	0.974	-.1951892	.1888855
OTHERsource	.5641653	.1193075	4.73	0.000	.3303269	.7980036
NOdep	-.601534	.0752363	-8.00	0.000	-.7489944	-.4540737
ENTRY1997	-.2156422	.1010515	-2.13	0.033	-.4136995	-.0175849
ENTRY1998	-.164172	.1029407	-1.59	0.111	-.3659321	.037588
ENTRY1999	-.0164092	.1039478	-0.16	0.875	-.2201431	.1873247
ENTRY2000	-.2462582	.1100109	-2.24	0.025	-.4618757	-.0306407
_cons	.4735532	.1143873	4.14	0.000	.2493581	.6977482

```
Probit regression, reporting marginal effects     Number of obs =   1728
                                                  LR chi2(16)   = 322.88
                                                  Prob > chi2   = 0.0000
Log likelihood = -1006.5155                       Pseudo R2     = 0.1382
```

PROMOTE	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
PRIORs~e*	-.0156263	.0299596	-0.52	0.602	.532407	-.074346	.043093
MASTdeg*	.3239658	.0249583	10.47	0.000	.229167	.275048	.372883
DOCTdeg*	-.3354565	.073211	-4.06	0.000	.026042	-.478947	-.191966
FPROdeg*	-.3421728	.145004	-2.05	0.040	.007523	-.626375	-.05797
OTHERdeg*	-.1924569	.0586534	-3.26	0.001	.054398	-.307415	-.077498
BLACK*	-.1217848	.0401878	-3.06	0.002	.124421	-.200551	-.043018
OTHERr~e*	-.0014091	.0389999	-0.04	0.971	.117477	-.077848	.075029
FEMALE*	.0040674	.0382924	0.11	0.916	.127894	-.070984	.079119
ROTCsch*	-.0540925	.0347663	-1.57	0.117	.278356	-.122233	.014048
USNA*	-.0012093	.0376007	-0.03	0.974	.252315	-.074905	.072487
OTHERs~e*	.1967068	.0363602	4.73	0.000	.111111	.125442	.267971
NOdep*	-.23303	.0288249	-8.00	0.000	.320602	-.289526	-.176534
ENT~1997*	-.0838697	.0396937	-2.13	0.033	.207755	-.161668	-.006071
ENT~1998*	-.063697	.0403085	-1.59	0.111	.203125	-.1427	.015306
ENT~1999*	-.006303	.0399814	-0.16	0.875	.199653	-.084665	.072059
ENT~2000*	-.0959667	.0433257	-2.24	0.025	.195023	-.180883	-.01105

obs. P	.5925926	
pred. P	.61032	(at x-bar)

```
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| correspond to the test of the underlying coefficient being 0
```

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APPENDIX E. HECKMAN PROBIT MODEL WITH SAMPLE SELECTION ANALYSIS INCLUDING "UNKNOWN EDUCATION" DEGREE

Probit model with sample selection

Number of obs	= 3668
Censored obs	= 1818
Uncensored obs	= 1850
Wald chi2(17)	= 121.35
Log likelihood = -3081.877	Prob > chi2 = 0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PROMOTE						
PRIORservice	-.1822411	.0637125	-2.86	0.004	-.3071154	-.0573669
MASTdeg	.3611746	.0900121	4.01	0.000	.1847542	.5375951
DOCTdeg	-.4299752	.1761119	-2.44	0.015	-.7751483	-.0848022
FPROdeg	-.9523283	.35738	-2.66	0.008	-1.65278	-.2518763
OTHERdeg	-.4365695	.127816	-3.42	0.001	-.6870842	-.1860548
UNKNdeg	-.144089	.1080349	-1.33	0.182	-.3558334	.0676555
BLACK	-.3098831	.0817542	-3.79	0.000	-.4701184	-.1496479
OTHERrace	-.0846134	.0813443	-1.04	0.298	-.2440454	.0748185
FEMALE	.1068737	.0757887	1.41	0.158	-.0416695	.2554168
ROTCsch	.0564347	.0754079	0.75	0.454	-.091362	.2042314
USNA	.1936632	.0793645	2.44	0.015	.0381116	.3492147
OTHERsource	.2871077	.1003206	2.86	0.004	.090483	.4837324
NOdep	-.2208105	.0721562	-3.06	0.002	-.362234	-.0793871
ENTRY1997	-.087666	.0847532	-1.03	0.301	-.2537793	.0784472
ENTRY1998	-.0024506	.0854844	-0.03	0.977	-.169997	.1650958
ENTRY1999	.0699395	.0848215	0.82	0.410	-.0963076	.2361865
ENTRY2000	.1115983	.0898572	1.24	0.214	-.0645186	.2877153
_cons	.8245141	.094223	8.75	0.000	.6398403	1.009188
STAY						
PRIORservice	.3973461	.055618	7.14	0.000	.2883368	.5063554
MASTdeg	1.684157	.1150343	14.64	0.000	1.458694	1.90962
DOCTdeg	-.5833233	.1388105	-4.20	0.000	-.855387	-.3112596
FPROdeg	.511542	.3558551	1.44	0.151	-.1859211	1.209005
OTHERdeg	.0172061	.1233913	0.14	0.889	-.2246364	.2590487
UNKNdeg	-.3846221	.0832175	-4.62	0.000	-.5477254	-.2215187
BLACK	.1718071	.0758558	2.26	0.024	.0231326	.3204816
OTHERrace	.2368298	.07199	3.29	0.001	.095732	.3779276
FEMALE	-.1960054	.0608322	-3.22	0.001	-.3152343	-.0767764
ROTCsch	-.4472611	.0669042	-6.69	0.000	-.578391	-.3161313
USNA	-.5622951	.0682446	-8.24	0.000	-.6960521	-.428538
OTHERsource	.1577631	.0931967	1.69	0.090	-.024899	.3404252
MARRIED	.6046849	.0662926	9.12	0.000	.4747537	.7346161
NOdep	.1356579	.0703148	1.93	0.054	-.0021564	.2734723
ENTRY1997	-.1191707	.0757132	-1.57	0.115	-.2675659	.0292245
ENTRY1998	-.2580573	.0740844	-3.48	0.000	-.4032601	-.1128545
ENTRY1999	-.2261756	.0738762	-3.06	0.002	-.3709703	-.0813809
ENTRY2000	-.4211012	.0745497	-5.65	0.000	-.567216	-.2749864
_cons	-.0743176	.1039572	-0.71	0.475	-.27807	.1294348
/athrho	-1.465964	.2518737	-5.82	0.000	-1.959628	-.9723008
rho	-.8988048	.0483975			-.9610614	-.7497136

LR test of indep. eqns. (rho = 0): chi2(1) = 54.12 Prob > chi2 = 0.0000

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APPENDIX F. HECKMAN PROBIT MODEL WITH SAMPLE SELECTION ANALYSIS EXCLUDING "UNKNOWN EDUCATION" DEGREE

Probit model with sample selection

Number of obs	= 3310
Censored obs	= 1582
Uncensored obs	= 1728
Wald chi2(16)	= 118.50
Log likelihood = -2806.194	Prob > chi2 = 0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PROMOTE						
PRIORservice	-.2035294	.0669047	-3.04	0.002	-.3346602	-.0723987
MASTdeg	.3899386	.0926343	4.21	0.000	.2083787	.5714984
DOCTdeg	-.4425908	.1805658	-2.45	0.014	-.7964931	-.0886884
FPROdeg	-.9443114	.3625582	-2.60	0.009	-1.654912	-.2337104
OTHERdeg	-.4275688	.129469	-3.30	0.001	-.6813235	-.1738141
BLACK	-.2849613	.0863053	-3.30	0.001	-.4541166	-.1158061
OTHERrace	-.1012037	.0860359	-1.18	0.239	-.269831	.0674236
FEMALE	.10601	.0809251	1.31	0.190	-.0526002	.2646202
ROTCsch	.0665385	.0785405	0.85	0.397	-.0873981	.2204751
USNA	.204528	.082825	2.47	0.014	.042194	.366862
OTHERsource	.333764	.1084728	3.08	0.002	.1211612	.5463669
NOdep	-.2356831	.0750456	-3.14	0.002	-.3827697	-.0885965
ENTRY1997	-.1045674	.086466	-1.21	0.227	-.2740376	.0649027
ENTRY1998	-.0051281	.0876285	-0.06	0.953	-.1768768	.1666206
ENTRY1999	.0786287	.0878379	0.90	0.371	-.0935305	.2507879
ENTRY2000	.0566283	.0971759	0.58	0.560	-.133833	.2470895
_cons	.8250449	.0975485	8.46	0.000	.6338534	1.016236
STAY						
PRIORservice	.3666609	.0589868	6.22	0.000	.2510488	.4822729
MASTdeg	1.715099	.115489	14.85	0.000	1.488744	1.941453
DOCTdeg	-.5364662	.1397403	-3.84	0.000	-.8103522	-.2625803
FPROdeg	.5604053	.3570455	1.57	0.117	-.1393911	1.260202
OTHERdeg	.055391	.1242245	0.45	0.656	-.1880846	.2988666
BLACK	.1701703	.0798297	2.13	0.033	.013707	.3266335
OTHERrace	.275105	.0771431	3.57	0.000	.1239074	.4263027
FEMALE	-.2060053	.0644237	-3.20	0.001	-.3322735	-.0797371
ROTCsch	-.3848872	.0715064	-5.38	0.000	-.5250372	-.2447371
USNA	-.5112309	.0718696	-7.11	0.000	-.6520927	-.370369
OTHERsource	.246463	.1031124	2.39	0.017	.0443664	.4485596
MARRIED	.6218503	.0696882	8.92	0.000	.485264	.7584366
NOdep	.1408467	.0743918	1.89	0.058	-.0049586	.286652
ENTRY1997	-.1088538	.0767498	-1.42	0.156	-.2592807	.0415731
ENTRY1998	-.2378573	.0755499	-3.15	0.002	-.3859323	-.0897822
ENTRY1999	-.2032724	.0764942	-2.66	0.008	-.3531982	-.0533466
ENTRY2000	-.4881065	.0779029	-6.27	0.000	-.6407933	-.3354197
_cons	-.1258342	.1086448	-1.16	0.247	-.3387741	.0871057
/athrho	-1.364619	.2323915	-5.87	0.000	-1.820098	-.9091402
rho	-.8774601	.0534649			-.9488482	-.7207193

LR test of indep. eqns. (rho = 0): chi2(1) = 47.82 Prob > chi2 = 0.0000

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APPENDIX G. STATA OUTPUT FOR ANALYSIS OF DEMOGRAPHICS AND ACCESSION SOURCES ON ADVANCED EDUCATION

```
Probit regression                                 Number of obs   =       3668
                                                  LR chi2(8)      =     254.02
                                                  Prob > chi2     =     0.0000
Log likelihood = -1388.0059                       Pseudo R2       =     0.0838
```

ADV_EDUC	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
BLACK	.0836388	.0841411	0.99	0.320	-.0812747	.2485523
OTHERrace	-.0928423	.0910394	-1.02	0.308	-.2712763	.0855917
FEMALE	-.1351847	.0794549	-1.70	0.089	-.2909135	.020544
MARRIED	.4541658	.0892491	5.09	0.000	.2792407	.6290908
NOdep	-.1011742	.0936707	-1.08	0.280	-.2847654	.0824169
ROTCsch	-.6312352	.0684042	-9.23	0.000	-.765305	-.4971654
USNA	-.5067943	.0694113	-7.30	0.000	-.6428379	-.3707508
OTHERsource	-.3091337	.0977116	-3.16	0.002	-.5006449	-.1176224
_cons	-.9314195	.095445	-9.76	0.000	-1.118488	-.7443507

```
Probit regression, reporting marginal effects     Number of obs =   3668
                                                  LR chi2(8)    = 254.02
                                                  Prob > chi2   = 0.0000
Log likelihood = -1388.0059                       Pseudo R2     = 0.0838
```

ADV_EDUC	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
BLACK*	.0178135	.0185809	0.99	0.320	.104962	-.018604	.054231
OTHERr~e*	-.018252	.0171257	-1.02	0.308	.108506	-.051818	.015314
FEMALE*	-.0263739	.014703	-1.70	0.089	.182661	-.055191	.002443
MARRIED*	.0924182	.0179184	5.09	0.000	.52072	.057299	.127538
NOdep*	-.0206213	.0189746	-1.08	0.280	.444656	-.057811	.016568
ROTCsch*	-.1145928	.0109786	-9.23	0.000	.327426	-.13611	-.093075
USNA*	-.0929469	.0114074	-7.30	0.000	.306707	-.115305	-.070589
OTHERs~e*	-.0543184	.0144893	-3.16	0.002	.082334	-.082717	-.02592
obs. P	.1444929						
pred. P	.1243578	(at x-bar)					

```
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| correspond to the test of the underlying coefficient being 0
```

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APPENDIX H. STATA OUTPUTS FOR DEMOGRAPHICS AND ACCESSION SOURCES ON MASTER'S DEGREE

```
Probit regression                                 Number of obs   =       1850
                                                  LR chi2(13)     =     168.69
                                                  Prob > chi2     =     0.0000
Log likelihood = -876.32092                       Pseudo R2       =     0.0878
```

MASTdeg	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PRIORservice	-.196487	.0817477	-2.40	0.016	-.3567097	-.0362644
BLACK	-.1068885	.1094726	-0.98	0.329	-.3214509	.1076739
OTHERrace	-.1245469	.1132728	-1.10	0.272	-.3465575	.0974637
FEMALE	-.1231099	.1126984	-1.09	0.275	-.3439947	.0977749
ROTCsch	-.190304	.0940323	-2.02	0.043	-.374604	-.0060041
USNA	-.1126289	.1026194	-1.10	0.272	-.3137593	.0885014
OTHERsource	-.4213964	.1274126	-3.31	0.001	-.6711206	-.1716722
MARRIED	.388423	.1256345	3.09	0.002	.1421839	.634662
NOdep	-.1924661	.1322114	-1.46	0.145	-.4515957	.0666635
ENTRY1997	.2246544	.1191902	1.88	0.059	-.0089541	.4582628
ENTRY1998	.2456249	.119229	2.06	0.039	.0119404	.4793094
ENTRY1999	.1601163	.1197442	1.34	0.181	-.074578	.3948106
ENTRY2000	.8869788	.1108988	8.00	0.000	.6696211	1.104337
_cons	-1.109591	.1729304	-6.42	0.000	-1.448528	-.7706534

```
Probit regression, reporting marginal effects     Number of obs =   1850
                                                  LR chi2(13)   = 168.69
                                                  Prob > chi2   = 0.0000
Log likelihood = -876.32092                       Pseudo R2     = 0.0878
```

MASTdeg	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
PRIORs~e*	-.0541677	.0226056	-2.40	0.016	.532973	-.098474	-.009862
BLACK*	-.02829	.0279132	-0.98	0.329	.124865	-.082999	.026419
OTHERr~e*	-.0327388	.0284652	-1.10	0.272	.117838	-.08853	.023052
FEMALE*	-.0324225	.0284428	-1.09	0.275	.13027	-.088169	.023324
ROTCsch*	-.0501652	.0237523	-2.02	0.043	.267027	-.096719	-.003611
USNA*	-.0300987	.0266932	-1.10	0.272	.239459	-.082416	.022219
OTHERs~e*	-.0990446	.0249392	-3.31	0.001	.112432	-.147925	-.050165
MARRIED*	.100432	.0304196	3.09	0.002	.666486	.040811	.160053
NOdep*	-.0512187	.0340752	-1.46	0.145	.324324	-.118005	.015567
ENT~1997*	.0651681	.0363474	1.88	0.059	.195676	-.006071	.136408
ENT~1998*	.0716007	.0366681	2.06	0.039	.195676	-.000267	.143469
ENT~1999*	.0456996	.0354573	1.34	0.181	.201622	-.023795	.115195
ENT~2000*	.2862848	.0390603	8.00	0.000	.222162	.209728	.362842
obs. P	.2140541						
pred. P	.193321	(at x-bar)					

```
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| correspond to the test of the underlying coefficient being 0
```

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APPENDIX I. BIVARIATE PROBIT MODEL FOR MASTER'S DEGREE AND PROMOTION

Seemingly unrelated bivariate probit — Number of obs = 1850
Wald chi2(26) = 875.84
Log likelihood = -1972.6523 — Prob > chi2 = 0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PROMOTE						
MASTdeg	2.103538	.1270055	16.56	0.000	1.854612	2.352464
PRIORservice	.0278586	.069198	0.40	0.687	-.1077669	.1634841
BLACK	-.2383603	.0928726	-2.57	0.010	-.4203872	-.0563335
OTHERrace	.0663422	.0918232	0.72	0.470	-.113628	.2463123
FEMALE	.0293471	.0900907	0.33	0.745	-.1472274	.2059216
ROTCsch	-.0005107	.0804626	-0.01	0.995	-.1582145	.157193
USNA	.093782	.0870136	1.08	0.281	-.0767616	.2643255
OTHERsource	.5301371	.1039977	5.10	0.000	.3263053	.7339689
NOdep	-.3724871	.0834296	-4.46	0.000	-.5360061	-.2089682
ENTRY1997	-.2612698	.0944709	-2.77	0.006	-.4464294	-.0761102
ENTRY1998	-.2341649	.0952035	-2.46	0.014	-.4207603	-.0475694
ENTRY1999	-.1329648	.0950226	-1.40	0.162	-.3192058	.0532761
ENTRY2000	-.5193678	.1029546	-5.04	0.000	-.7211551	-.3175806
_cons	.0378458	.1142699	0.33	0.740	-.1861191	.2618107
MASTdeg						
PRIORservice	-.2096121	.0795742	-2.63	0.008	-.3655748	-.0536495
BLACK	-.0974461	.1074049	-0.91	0.364	-.3079558	.1130636
OTHERrace	-.1174207	.1112982	-1.06	0.291	-.3355611	.1007197
FEMALE	-.1267396	.1074108	-1.18	0.238	-.3372609	.0837816
ROTCsch	-.1708606	.0922572	-1.85	0.064	-.3516814	.0099602
USNA	-.1102588	.0994925	-1.11	0.268	-.3052606	.084743
OTHERsource	-.4310885	.1310434	-3.29	0.001	-.6879287	-.1742482
MARRIED	.5392057	.1112181	4.85	0.000	.3212222	.7571891
NOdep	-.0336751	.1224102	-0.28	0.783	-.2735946	.2062445
ENTRY1997	.2147919	.1182676	1.82	0.069	-.0170084	.4465922
ENTRY1998	.2678719	.1178883	2.27	0.023	.0368151	.4989286
ENTRY1999	.1792422	.1180784	1.52	0.129	-.0521871	.4106716
ENTRY2000	.8884402	.1098257	8.09	0.000	.6731857	1.103695
_cons	-1.257273	.1624473	-7.74	0.000	-1.575663	-.9388819
/athrho	-1.046979	.3229326	-3.24	0.001	-1.679916	-.414043
rho	-.7806292	.1261433			-.9328506	-.3919001

Likelihood-ratio test of rho=0: chi2(1) = 13.2528 Prob > chi2 = 0.0003

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